Power Engineering

FEBRUARY 1961

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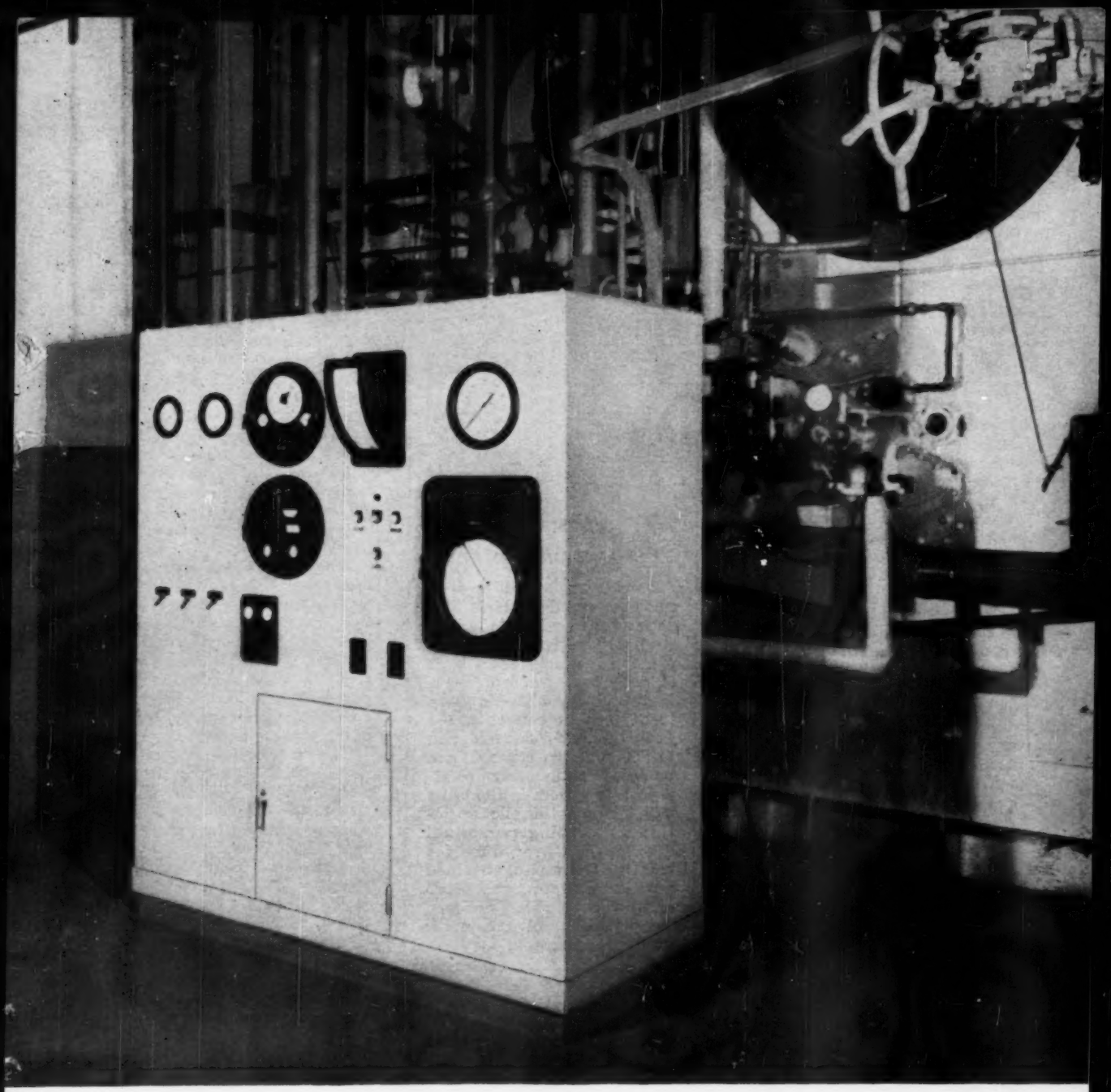
COAL—FROM MINE TO BOILER 47

New B&W Boilers Cut Heating Costs 22% for Country's 3rd Largest Building

American Furniture Mart Corporation replaces 3 previous boilers with 2 B&W package units . . . Heats 29 Million cubic feet at fuel cost saving of 22%

The American Furniture Mart dominating Chicago's skyline with a 17 story building topped by a 33 story tower . . . has 29 million cubic feet of space to be heated. It is the largest commercial building in the world devoted to a single industry, home furnishings. Throughout the year, it is the national purchasing center for thousands of retail stores, large and small, and at peak markets, upwards of 45,000 buyers and sellers shop its display spaces. The recent installation of two B&W boilers . . . in place of three previous units . . . provides all the steam necessary for this large heating job at a fuel cost saving of 22%. Additional economies can be realized because fuels can be switched in a matter of minutes



to use the fuel most economical at any given time. Moreover, these new boilers are fast steaming . . . put out plenty of heat in a hurry even after being turned off all night.

In addition to cutting fuel costs, a savings that will pay for the units in five years, these B&W package boilers cut space requirements in half and require fewer men to keep them in operation. It is interesting to note, too, that these boilers were installed during the height of the heating season . . . with minimum loss of heat to the building's occupants during the changeover period. Furthermore, management knows that any time in the life of the boiler — 10, 20 or 30 years hence — B&W's nation-wide service organization will be promptly and economically available if needed.

Providing the efficiency, economy, and service necessary to heat the country's third largest building economically is further evidence-in-action of dependable steam generation by B&W. Whatever your steam requirement . . . whatever your most economical fuel . . . B&W has the boiler best suited to your heating application. For information, contact your local B&W representative. He has all the facts on your area. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

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THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

Hall Industrial Water Report

VOLUME 9 FEBRUARY 1961 NUMBER 1

Ignoring a problem will not solve it

But some industrial waste water problems are being ignored until state authorities threaten to stop plant operations. Then there is often a frantic scramble to clean up waste waters in the short grace period which is usually allowed.

How much more orderly, effective, efficient and economical it is to make a thorough survey of the whole plant before the heat is on! All uncontaminated water should be segregated for reuse or disposal. All pollution of water should be minimized at the source before treatment procedures are considered. All processes should be studied to control water usage and to avoid loss of valuable materials.

Hall Laboratories is particularly well equipped to help you with waste water problems—as well as plant-wide water management, from procurement through process, cooling and boiler use to final disposal.

Wasted raw material

A rubber manufacturing plant uses a clay slurry to coat an intermediate product. During a preliminary process and waste water survey, Hall staff engineer E. G. Paulson was informed that not more than 10 percent of the clay was being lost from the process. However, the gauging and sampling program and material balance calculations showed that more clay was being discharged from the plant than could be accounted for by production figures.

The gauging and sampling program was repeated. Results checked those obtained previously. To pin down the source of suspended solids in the plant effluent, Paulson had the suspended material identified by petrographic and X-ray diffraction procedures. Sure enough, 90 percent of the clay was being discharged to a stream rather than adhering to the product.

This is a pilot plant

Pilot plants are not always as small as one might think. Size depends on what is being studied. The relatively large plant in the picture was built to study waste water problems for two nearby mills—to study treatment of concentrated waste dumps for one mill, and to define design criteria for a proposed continuously operating waste system in the other mill. Through this pilot operation, operating personnel developed a procedure for treating the waste, obtained practical operating experience and had a plant large enough to temporarily solve the waste problem at one mill.

Through the joint efforts of Paulson and the plant engineers, the process was revised to save the bulk of the clay. Estimates indicated that the saving in raw material would pay the cost of the process changes in approximately nine months.

Long-range planning pays off

Because plant management at a detinning plant wanted to arrive at thoroughly sound decisions on procedures and facilities needed to render waste waters suitable for discharge, they had Hall staff engineers work on the problem for several years.

At the time the first survey was made, sanitary and process wastes were combined. The first change involved segregation and discharge of sanitary waste to a municipal sewer. The process waste water came from seven different operations. Samples from each were analyzed. Three waters were uncontaminated practically all of the time. One was polluted occasionally. Usage of water was modified to reduce the volume of contaminated water.

When all in-plant changes had been completed, another survey was made. One flowing rinse water and two concentrated solutions, dumped batchwise, now accounted for all polluted water. Through co-operative efforts the plant's research department and Hall's laboratories developed a procedure for treatment of the waste water.

The analytical work done in connection with the survey led to the realization that a considerable quantity of tin was being lost in waste water. A little further work showed that it should be possible to recover enough metal to increase plant income by $300 per day. This major saving prompted drastic revision of process which in turn reduced polluted water volume to three relatively small batches per week. This water is easily treated by the process developed by plant and Hall Laboratories personnel.

New booklet available

A new 24-page booklet describes the many ways industry can use Hall Laboratories industrial water consulting services.

For your copy, write on your letterhead to:

HALL LABORATORIES
HAGAN CENTER, PITTSBURGH 30, PA.
Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

DIVISION OF **HAGAN** CHEMICALS & CONTROLS, INC.

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HERE'S SOME FOOD FOR THOUGHT

Editors of technical magazines attend dozens of conferences and shows every year—and they talk to lots of very important people. In this capacity we gather plenty of information—both technical, and of a personal nature. When we sense a general trend, and see it gaining momentum rapidly, we feel it's our duty to disseminate the information we've gained.

This issue of POWER ENGINEERING *contains an editorial which should interest all those who ever attend technical meetings, conferences, or equipment exhibitions. Power engineers in utility companies, consulting and engineering firms, industry, and the construction field should all give some thought to the views expressed.*

We are now convinced that there is a universal demand for one good Power Conference and Show—devoted entirely to the practical aspects of the power field. And we have proposed a plan for such a program.

So—we sincerely ask all you readers to study the article on page 45, and give us your comments—pro or con. Thanks for your cooperation.

Bob McCaw
EDITOR

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Engineers' Preview

OF NEWS AND COMING EVENTS IN THE POWER FIELD

FOR 1961, Edison Electric Institute reports that the electric companies plan to expend about $3.41 billion for new plant and equipment. During the year, they plan to add about 7.5 million more kilowatts of generating equipment. Governmental agencies are expected to add another 3.8 million kw during the year, EEI says. Expected capability for the total industry in contiguous U.S. at the end of the year is 187.2 million kw, 6.5 per cent over the 1960 figure.

EEI's prediction is that by the end of 1961, electricity output in the U.S., including Alaska and Hawaii, will be 7 per cent higher than in 1960, totaling some 910 billion kwh. Sales by all parts of the industry in the contiguous United States are estimated to reach a new peak of 715 billion kwh, 7.2 per cent over the 1960 record. The number of customers is expected to increase to 59.8 million by the end of the year. The investor-owned companies should increase their revenues by about 6.8 per cent over 1960, reaching $12¼ billion for 1961.

According to preliminary figures, electric energy output (including imports from Canada) by the total electric utility industry in the contiguous U.S. is estimated to have reached a record high of 764.8 billion kwh during 1960, an expected increase of some 45.3 billion kwh, or 6.3 per cent over 1959.

With the addition of the electricity generated by industrial plants and by railways not contributing to the public supply, and of generation in Alaska and Hawaii, the United States' output is expected to have reached a record total of 850 billion kwh in 1960.

Production of electricity within the United States (including Alaska and Hawaii and excluding imports) reached a record high of 845 billion kwh.

BRITAIN's Central Electricity Generating Board has placed an order for a Bristol Siddeley 15-Mw gas turbine-generator set. The set will be located at Hams Hall, near Birmingham, and is expected to go into operation in September, 1962.

This is the first order to be placed for equipment of this type. The new installation is intended to demonstrate the ability of the gas turbine to meet the requirements of national electricity authorities and of large industrial concerns, both for peak load operation and for maintaining a supply of electricity in the event of an emergency.

FOURTEEN representatives from various segments of the nation's coal industry have been appointed as members of a general technical advisory committee for the Department of the Interior's new Office of Coal Research. Members of the committee were appointed for a two-year term. They are:

G. A. Shoemaker, Consolidation Coal Co; Harry LaViers, South-East Coal Co; R. E. Salvati, Island Creek Coal Co; F. S. Elfred, Peabody Coal Co; Philip Sporn, American Electric Power Co; Michael F. Widman, Jr, United Mine Workers of America; S. T. Saunders, Norfolk and Western Railway; H. B. Charmbury, Pennsylvania State University; G. R. Spindler, West Virginia University; Walter K. Scherer, Fred Scherer, Inc; J. D. Jillson, Anthracite Institute; Maurice H. Bigelow, Allied Chemical Co; Samuel Lenher, Du Pont; W. L. Wearly, Joy Manufacturing Co.

EBASCO SERVICES, Inc, has completed a second 100,000-kw generating facility at Glenrock, Wyoming, for the Pacific Power & Light Co. Called the Dave Johnson Steam Electric Station, this new plant now has a total capacity of 200,000 kw. The first 100,000-kw unit was completed by Ebasco two years ago.

POWER POOL is being formed to include the electric systems of four investor-owned power companies and one rural electric cooperative in an area including parts of Minnesota, Wisconsin, Iowa, North Dakota and South Dakota. The pool members are: Otter Tail Power Co, Northern States Power Co, Interstate Power Co, Dubuque, Iowa, Minnesota Power and Light Co, Duluth, and Dairyland Power Cooperative, LaCrosse, Wisconsin. Pool will be known as the Upper Mississippi Valley Power Pool. The five power suppliers have a combined generating capability of more than 3,100,000 kilowatts.

ADOPTION of a unique tunnel-driving technique based on the use of the Swedish-designed Alimak raise climber has cut the construction time for the feed tube of the Swedish State Power Board's new Stalon plant by more than 50 per cent. This 100-Mw hydro-power station, originally scheduled for a construction time of seven years, will go into operation in September of this year, after just over three years of work.

The raise climber device used for the driving of the feed tube was developed by Alimakverken, Skellefteå, a couple of years ago mainly for application in mines and is based on their experience in making construction and maintenance

Protect steel stacks with corrosion-resistant concrete

Corrosion-resistant concrete linings, made with LUMNITE calcium-aluminate cement and suitable aggregate, will protect stacks and breechings from the corrosive action of condensate.

When expanded shale aggregate is used, these linings also provide vital insulation. This keeps stack gases hot and helps maintain better draft for greater operating efficiency. The steel shell will stay cooler, too, extending the life of exterior paint. And these monolithic concrete linings have a lower unit weight, which reduces the dead load on the supporting structure.

Whether gunited or plastered, installation is easy and economical, with concrete reaching service strength in 24 hours. For even greater convenience, manufacturers of refractories offer castables bonded with LUMNITE cement – packaged mixtures ready for use with just the addition of water.

For more information, write Universal Atlas Cement, 100 Park Avenue, New York 17, N. Y.

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platforms for the building industry. The platform, which accommodates four drillers, rises on a guide bar composed of attachable units and is operated by a compressed-air motor. The guide bar also carries air and water conduits and electric cables.

When a drilling shift has been completed the working platform is lowered to the bottom of the shaft and retracted during the shooting round. After the shaft has been cleared the platform is raised again.

GOVERNMENT APPROVAL has been given to agreements between the Navajo Indian Tribe and the Arizona Public Service Co which provide for large-scale development and sale of electric power on the Navajo Reservation in Arizona, New Mexico and Utah.

Tribal land on the San Juan River across from Fruitland, New Mexico, will be leased to the company as a site for the construction of steam generating facilities, a reservoir for cooling purposes, and other facilities. Two units of 175,000 kw each are planned immediately, and later expansion is contemplated.

The first two units, together with transmission lines and other related facilities, are expected to cost approximately $100 million. Ultimate cost of the total development may run as high as $180 million.

AN IMPROVED 50,000-gpd sea water distilling plant of the four-stage low temperature flash type, first of six being built under a U.S. Navy contract, has been completed by Badger Mfg. Co.

The unit is the first ever built under new Navy specifications which allow use of U-tube bundles in the condensers rather than conventional straight tubes. Weighing 18 tons and measuring 16 ft long by 11 ft wide by 10 ft high, the unit is reported to be some 20 per cent lighter and 50 per cent smaller than conventional flash distilling plants of equivalent capacity.

Production run tests indicate that the evaporators will provide better than the 3.75 lb of distilled water per pound of steam supplied. When actually installed on shipboard, the steam supply will come from the auxiliary exhaust steam from the main turbine at 15 psi.

PRIVATE INDUSTRY spent $9.4 billion for research and development in 1959, the National Science Foundation reports. This was 15 per cent higher than the 1958 level. Two industries that far exceeded all others in the amount of research expenditures in 1959 were aircraft and parts ($2973 million) and electrical equipment and communication ($2227 million).

NEW 500,000-kw, $65-million steam-electric generating unit at the Philip Sporn Plant of the American Electric Power System has been placed in commercial operation. Twin to the unit recently completed at Breed Plant in Indiana, this newest "biggest" unit is located on the Ohio River at Graham Station, W. Va., and is owned by Ohio Power Co. It was begun in 1957, has GE water-cooled generators, a 23-story boiler which provides steam at 1050 F and double reheat at 1050 F. At 3500-psi pressure the Sporn Plant unit is well above the critical pressure level of 3206 psi. Its heat rate is expected to be close to 8500 Btu per kwh.

NATION's largest extra-high-voltage capacitor bank, built by General Electric for the Bonneville Power Administration, has successfully passed field acceptance tests. This installation is used to balance loading on Bonneville's 345,000-v transmission system. The capacitor substation is located along the Columbia River in Washington, about 120 miles east of Portland, Oregon.

The bank is composed of 2160 50-kilovar capacitors divided into six identical blocks, two blocks for each phase. Each block is mounted on a special insulated platform and held in aluminum stack racks.

ON DECEMBER 2, 1960, at 7:51 A.M., the first of the eight nuclear reactors aboard the USS Enterprise, under construction at Newport News, Va., achieved criticality. This is the first sustained nuclear reaction ever performed on an American surface ship and occurred on the 18th anniversary of the first nuclear chain reaction in history. This prior historic event took place under the west stand of Stagg Field at the University of Chicago on December 2, 1942.

PEAK GENERATION from both hydro and steam plants on the TVA system set a new record December 13, exceeding 10 million kw for the first time. December 13 also brought the all-time peak in net system load — the requirements of TVA's customers at a given time. This peak load reached 9,939,000 kw, an increase of nearly 300,000 kw over last winter's peak which occurred during March.

The same day also set a new record for the TVA system in electricity generated on a single day. This total was 216.4 million kwh.

NEW experimental electric generator, using the revolutionary principle of magnetohydrodynamics (MHD) and with a possible power output much greater than the previous model, is undergoing initial shakedown runs at the Avco Everett Research Laboratory in Everett, Mass.

This intermediate generator is a step between the pioneer laboratory device announced last year by Avco and a group of ten utility companies, and an eventual full-scale commercial power station. The original Avco MHD generator weighed three tons and produced ten kilowatts for brief periods.

FOR YOUR CALENDAR: National Electrical Week is being observed Feb 5–11. Theme of the celebrations is Making Electricity Work for You.

Sixth annual gas turbine conference and products show will be held at the Shoreham Hotel in Washington, D.C., Mar 5–9. Sponsors are ASME's Gas Turbine Div and the Dept of Defense.

American Power Conference meets at the Hotel Sherman in Chicago, Mar 21, 22 and 23.

American Welding Society will hold its annual exposition and technical meeting in New York City, April 17–21, at the Coliseum and Commodore Hotel.

Western Joint Computer Conference is scheduled for May 9–11, in Los Angeles. Sponsors are the Institute of Radio Engineers, AIEE, and the Association for Computing Machinery.

Design Engineering Show will be presented May 22–25 in Cobo Hall, Detroit. ASME's machine design division will sponsor the event for the sixth consecutive year.

BOILERS TO GO!

Delivered to the installation site by rail, truck or boat, shop-assembled Vogt Package Water Tube Boilers can be quickly placed in operation. After being placed from the carrier onto a simple low-cost concrete slab, a Vogt unit requires only piping, electrical and stack connections to go to work.

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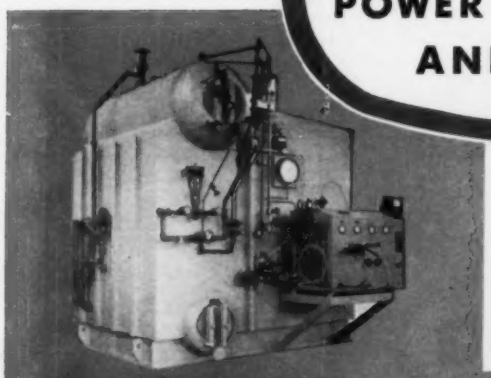
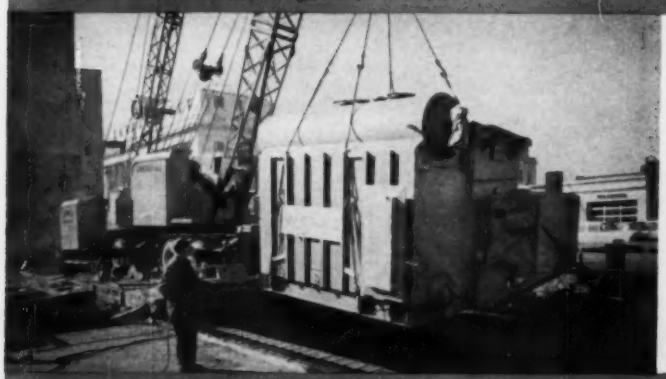
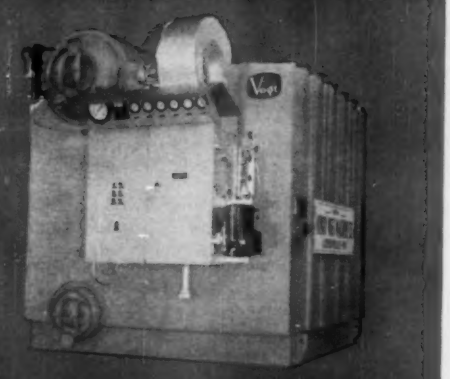


BOX PLANT — A 10,000 pounds/hour unit

HOSPITAL — Two 30,000 pounds/hour units



PRINTING PLANT — Two 20,000 pounds/hour units



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COMMENT, OPINION, AND NEWS ABOUT PEOPLE

▶ It's good to hear from readers on any subject, this one especially — from **Raymond W. Koelle,** chief of the Engineering Div of the U. S. Veterans Administration Hospital in Brockton, Mass.:

> Your magazine has been of great value to me, my supervisors and to our operation and training program.

And from **A. Spinney,** at a U. S. Naval Hospital in Boston:

> For current technical know-how and modern power engineering equipment you are tops.

▶ **James C. McElnay,** chief engineer of Greater Niagara General Hospital in Niagara Falls, Ontario, writes:

> Just want to say POWER ENGINEERING covers the field better than any other magazine I know, and I receive 12 different magazines each month. Thank you.

▶ **R. L. Nailen's** series of three articles on bearings for electric motors (May, June and July issues, 1960) make a helpful contribution to the literature on this subject. About these articles, O. Wulfert, chief mechanical engineer of Wagner Electric Corp's electrical division, comments:

> The articles are certainly well written and contain much useful information. Our compliments to the author for preparing these articles and to POWER ENGINEERING for publishing them.

▶ **J. A. MacLeod,** a power engineer for Burns and Roe, Inc, of New York City, writes in reference to the article, Floating Power in the Arctic, December, 1960 issue, page 76:

> I find a considerable interest in your article on the power ship at Thule and have been asked by a number of Air Force officers here at Thule for a copy of the article. I first marked a card for six copies, then 12, than 20; however, I would like to order 100 copies now.
>
> POWER ENGINEERING continues to supply me with highly pertinent and interesting articles in the power field.

▶ Pacific Gas & Electric Co's geothermal generating station — first of its kind in this country — is now operating at The Geysers in northeastern Sonoma County in northern California. Turbine generator of the 12,500-kw plant is driven by steam from wells drilled into volcanic formations in the earth. The plant uses about 240,000 lb of steam per hour, which strikes the turbine at 100 psi, 350 F. In dedicating the plant, PG&E's president **Norman R. Sutherland** said:

> This unique plant — small but very significant — is a triumph of vision and determination. The enterprising men who kept coming here over the years determined that the natural heat energy could be put to work. They kept at it until they proved they were right.

▶ **Ramon M. Guzman's** two-part article on corrosion by CO_2 in steam condensate lines appeared in our Handbook department over a year ago (Nov and Dec, 1959). Now we hear from **Rafael A. Domenech,** president of the Colegio de Ingenieros, Arquitectos y Agrimensores de Puerto Rico, that the article has been reprinted in the college's quarterly Review:

> Please accept our thanks for granting us permission to reprint Mr. Guzman's article.

▶ **Curtiss D. Bassett,** vice-president of Cummins & Barnard, Inc, consulting engineers in Ann Arbor, Mich., announces that the firm is opening a branch office in California through affiliation with Matson Associates, at 14568 Whittier Blvd, in Whittier.

▶ **Charles W. Watson** has been named vice-president, general administration, for Philadelphia Electric Co. Since 1957 he has been serving the company as assistant to the president.

Walter L. Peterson, manager of Allis-Chalmers' regulator department since 1956, has been appointed assistant manager of the motor and generator department. **Robert E. Horn** has been made acting manager of the regulator department.

Dwight D. Eisenhower has been awarded the Hoover Medal by ASME, AIEE, ASCE and AIMMPE. Eisenhower is the second President to receive the honor. Herbert Hoover, after whom the medal is named, was its first recipient in 1930.

Robert M. Atkinson, chairman of Sulzer Bros. (London) Ltd, died in London on November 12. He had joined the Sulzer organization in 1938, after many years with Vickers Ltd.

▶ **Tor Kolflat,** associate in Sargent & Lundy, writes concerning our special section on power for peaking, Oct issue, 1960:

> In reading the entire grouping of articles you presented on the special subject of peaking, I believe that an excellent job was done on your part, and we have heard many favorable comments.

▶ If the United States pursues sound economic policies at home, the industrial resurgence of other nations will be beneficial rather than destructive to the American economy, in the opinion of the **National Association of Manufacturers.** The Association says in a recent study:

> Foreign competition can have the same helpful effects that domestic competition has. In fact, foreign competition can have an even more beneficial effect, since it tends to impose on our whole economy the same discipline which internal competition imposes on the workings of individual firms.

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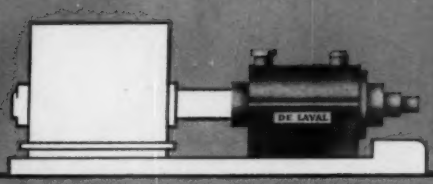
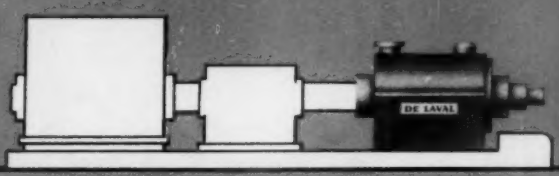
BOILER FEED PUMPS

Proven Design Flexibility and Experience

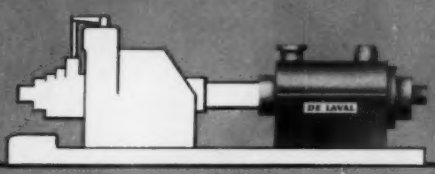
Direct Motor Drive
Atlantic City Electric Co.
2000 HP 125 MW



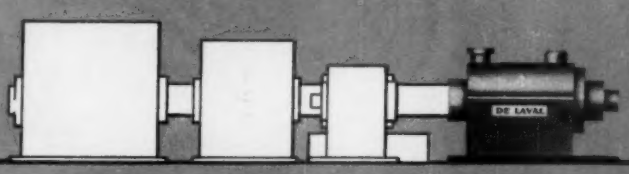
Motor-Hydraulic Coupling Drive
Commonwealth Edison Co.
5000 HP 325 MW



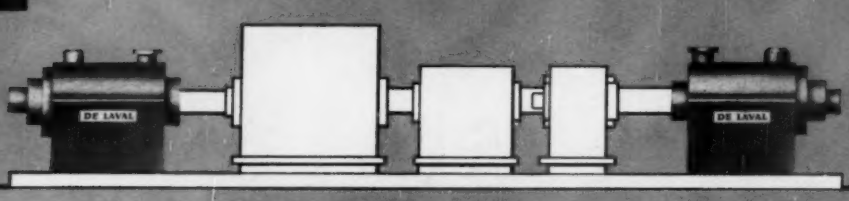
Turbine Drive
United States Steel Corporation
1400 HP 44 MW



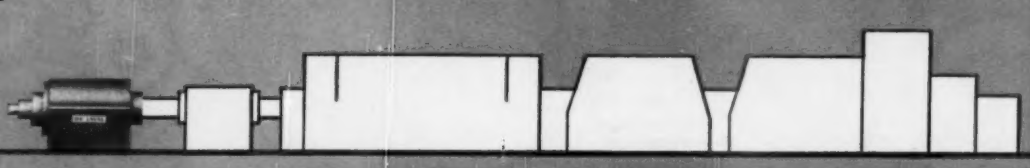
Motor-Magnetic Coupling—Gear Drive
South Carolina Electric & Gas Co.
2500 HP 5100 RPM
125 MW



Supercritical Cycle
American Electric Power System
4000 HP 6500 RPM 5500 PSIG 120 MW



Main Generator-Shaft Drive
Commonwealth Edison Co.
4900 HP 325 MW
(FUTURE UNIT)



Main Turbine-Shaft Drive
Pacific Gas & Electric Co.
5250 HP 330 MW

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...AND FUSES PROVIDE THE HIGHEST DEGREE OF PROTECTION AVAILABLE

Unlike mechanically operated devices, fuses have no hinges, pivots or contacts to stick or get out of order. They require no periodic inspections, recalibration and corresponding down-time. A fuse is just as safe and accurate 20 years or longer after installation as it is on the day installed.

Buss LOW-PEAK Fuses
200,000 amp. interrupting capacity . . . great current limitation . . . plus long time-lag.
Ask for Bulletin LPCS

FUSETRON dual-element Fuses
All purpose protective device for circuit, motor or equipment protection.
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Buss Hi-Cap Fuses
For loads above 600 and up to 6,000 amps. 200,000 amp. interrupting capacity, —plus current limitation.
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Buss LIMITRON Fuses
High interrupting capacity fuses with exceptional current limitation.
Ask for Bulletin HLS

BUSS makes a complete line of fuses for home, farm, commercial, electronic, electrical, automotive and industrial use.

161

Buss Super-Lag Renewable Fuses
Lowest cost protection where periodic short-circuits are frequent.
Ask for Bulletin RCS
Buss One-Time Fuses
Low cost, safe protection for heating or lighting circuits where faults do not exceed 10,000 amp.
Ask for Bulletin NCS
Buss Clear Window Plug Fuses
One piece body and "safety" design guarantee protection.
Ask for Bulletin WUS
Buss FUSTAT Fuses
Fusetron fuses with Type "S" base resist overfuseing or tampering.
Ask for Bulletin SCPS
Fustats for motor protection.
Ask for Bulletin SMPS
FUSETRON dual-element Plug Fuses
Safely stop needless blows. Give full protection against short-circuits and overloads.
Ask for Bulletin TCPS
BUSS and FUSETRON Small Dimension Fuses and Fuseholders
For the protection of all types of electric and electronic devices.
Ask for Bulletin SFB
Get the Facts... write
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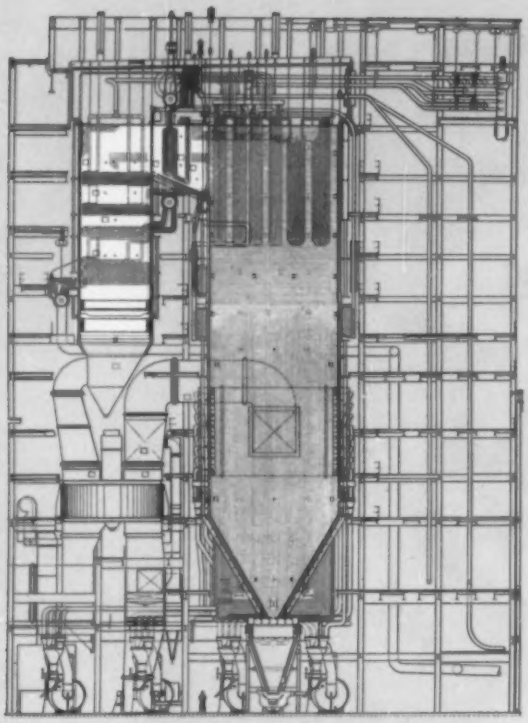
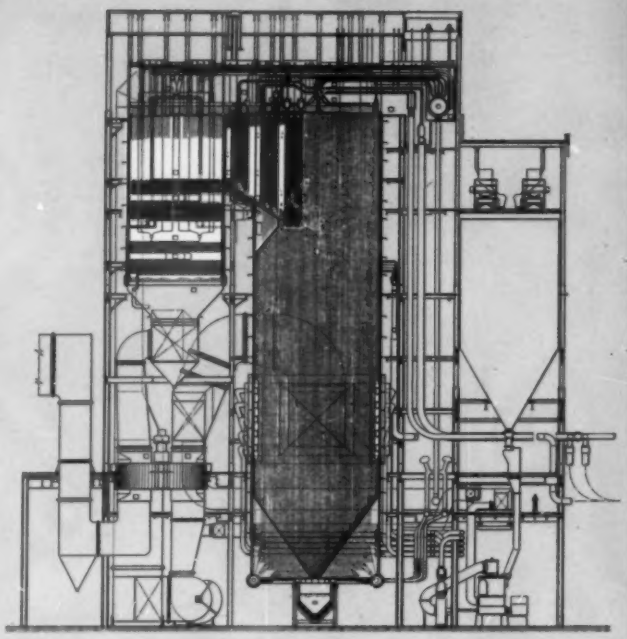
University at Jefferson, St. Louis 7, Mo.



The unit pictured here represents the most advanced power plant cycle yet attempted. This boiler, a C-E Sulzer Monotube Steam Generator, is designed to deliver 1200 F steam at a pressure of 5000 psi to a 325-megawatt turbine-generator. The unit employs a double reheat cycle (1050 F—1050 F) and has a primary steam flow of 2,000,000 lb per hr. It went on the line in February, 1960.



This boiler, a C-E Controlled Circulation unit, serves the world's first 500-megawatt turbine-generator. Designed for a primary steam flow of 3,850,000 lb per hr, it delivers 1050 F steam (1000 F reheat) at 2450 psi. It was placed in service in 1960.

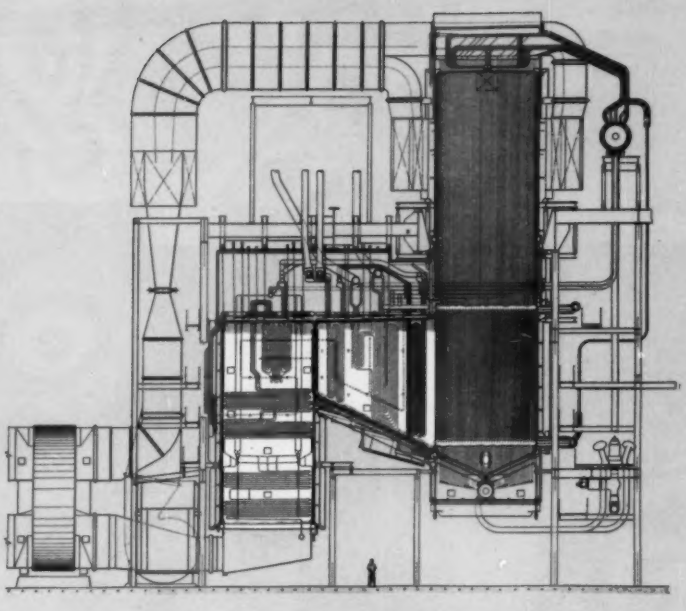
PROFILES

In 1950, a decade ago, Combustion installed some 40 utility boilers, representative of the complete range of power practice at that time. The average turbine capacity was 50 megawatts . . . the largest, 120 mw. All boilers were of natural circulation design, only two used reheat, only two had design pressures as high as 1800 psi. By contrasting these statistics with those of the boilers shown above, the length of the strides taken in the last ten years can be more fully appreciated.

A broader picture of current practice is revealed by the following data relative to 1960 C-E utility installations, which will serve nearly 4,000 mw of new capacity. Six of these boilers will power turbines of 225 mw and above, the largest serving a 500-mw turbine. All but two are designed for pressures in excess of 1800 psi . . . all employ reheat . . . about 60 per cent are of Controlled Circulation design. More than 70 per cent of the units serve turbines with capacities from 150 mw up. In fact, the average unit size is more than three times that of ten years ago, and the largest has

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;

Shown here are three C-E boilers, each of which represents an advanced design concept. Their major points of difference concern capacities, cycles, configurations — considerations of major import in the industry's continuing effort to keep power costs down. As indicated by the picture captions, one unit (far left) is the world's highest pressure boiler and represents the most advanced and efficient cycle yet attempted in power plant practice. Another (left) is the world's largest boiler, serving the first 500-megawatt turbine-generator to go into service. Both of these units went "on the line" in 1960. Although different in design, both follow the same general pattern which has long been characteristic of large C-E utility boilers. The third boiler (right) represents a marked departure from this classic arrangement. Because of the flexibility of its C-E Controlled Circulation design, heating surface can be placed in almost any desired position. Thus, it becomes possible to effect sizable savings in structural steel, stairs, platforms, piping, earthquake-proofing, as well as in the boiler itself.



This new look, made possible by the flexibility inherent in C-E Controlled Circulation design, holds much promise of bringing new first-cost economies to power plant practice. This reheat boiler is designed to deliver 1050 F steam (1000 F reheat) at 2400 psi to a 300-megawatt turbine-generator. It has a primary steam flow of 2,305,000 lb per hr.

# of Power Progress

over four times the capacity of the biggest unit of 1950.

During the last decade, the vocabulary of the power plant has been enlarged with the addition of such words and phrases as "skin casing," "divided furnaces," "twin furnaces," "panel wall," "welded wall," "subcritical," "supercritical," "platens," "pressurization." They account, in large measure, for the fact that, while generating costs have risen considerably over the last ten years, the average net production cost per kw-hr is substantially less today than it was in 1950.

COMBUSTION ENGINEERING

C-298

General offices: Windsor, Connecticut
New York offices: 200 Madison Avenue, New York 16

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

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Lower fuel costs . . . reduced boiler outage . . . minimum manual cleaning . . . inhibited tube corrosion—these are dramatic savings achieved by Diamond Chemical Slurry Spraying Systems, a revolutionary method of controlling and removing tube deposits generated by burning oils high in vanadium, sodium and sulphur content.

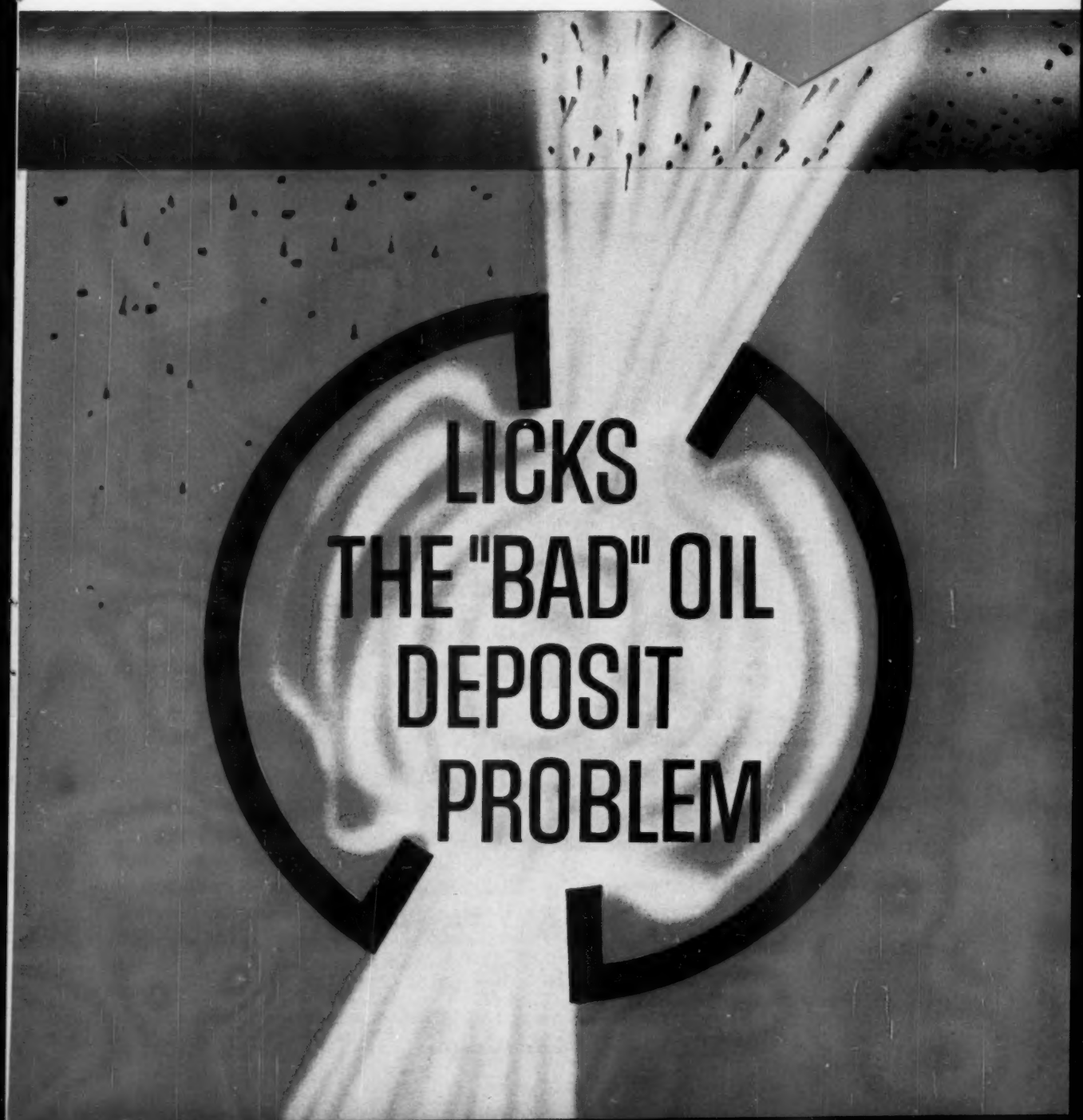
Service tested on some 40 installations, Diamond Slurry Spraying offers a distinct economic advantage over fuel additives because it treats only that ash which collects on the tubes. Magnesium oxide-based slurry is sprayed on heating surfaces by conventional soot blowers modified to discharge, in alternate cycles, both the normal cleaning medium and slurry. The chemical slurry coating changes chemical composition of deposit so that it's easily removed by normal blowing.

If you burn — or are considering burning low-grade oil, it will pay you to take a close look at Chemical Slurry Spraying . . . another Diamond-Developed Boiler Cleaning System. At your request, our engineers will make recommendations based on your specific requirements. Call, write or wire for complete information.

DIAMOND POWER SPECIALTY CORPORATION, Lancaster, Ohio

DIAMOND SPECIALTY LIMITED, Windsor, Ontario

Diamond



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USED TO THINK EVERY STEAM TRAP LEAKED STEAM.
THEN I FOUND ONE THAT DIDN'T, BUT IT WOULDN'T VENT AIR.
FOUND ONE THAT VENTED AIR, BUT IT NEEDED A COOLING LEG.
DISCOVERED A TRAP THAT REMOVED CONDENSATE AT STEAM TEMP, -MAINTENANCE WAS TOO HIGH.
THEN I FOUND A LOW MAINTENANCE TRAP. IT DIDN'T WORK AGAINST BACK PRESSURE.
AT LAST I FOUND ONE THAT WORKED AGAINST BACK PRESSURE, BUT ITS CAPACITY RATING WASN'T DEPENDABLE.
ARMSTRONG PROMISES TRUE CAPACITIES AND EVERYTHING ELSE, SO I CALLED THEM. THEY TOLD ME TO RELAX. I COULDN'T.
THEY TOLD ME ABOUT ARMSTRONG'S GUARANTEE. WHAT'D I HAVE TO LOSE, I TRIED THEM.
EFFICENCY IS UP, FUEL BILLS ARE DOWN. SO ARE MAINTENANCE COSTS. MAN I'M LIVING!

No one trap can do *everything* better than every other trap. Some traps vent air better than others, some remove condensate faster, etc. But, there is no one trap *best* in every phase of trapping. Armstrong has been manufacturing the Inverted Bucket Trap for nearly fifty years, and though the traps have changed with the requirements of the times, the Inverted Bucket principle has remained. For on overall trap performance, year-in and year-out, nothing beats the Armstrong Inverted Bucket Trap. It's a rugged well-built trap that does *more* things better than any other trap. It's guaranteed because it's been proved.

For more details, see your Armstrong Representative and start living . . .

P. S. Like some good meaty reading? Ask for the 48-page Armstrong Steam Trap Book.

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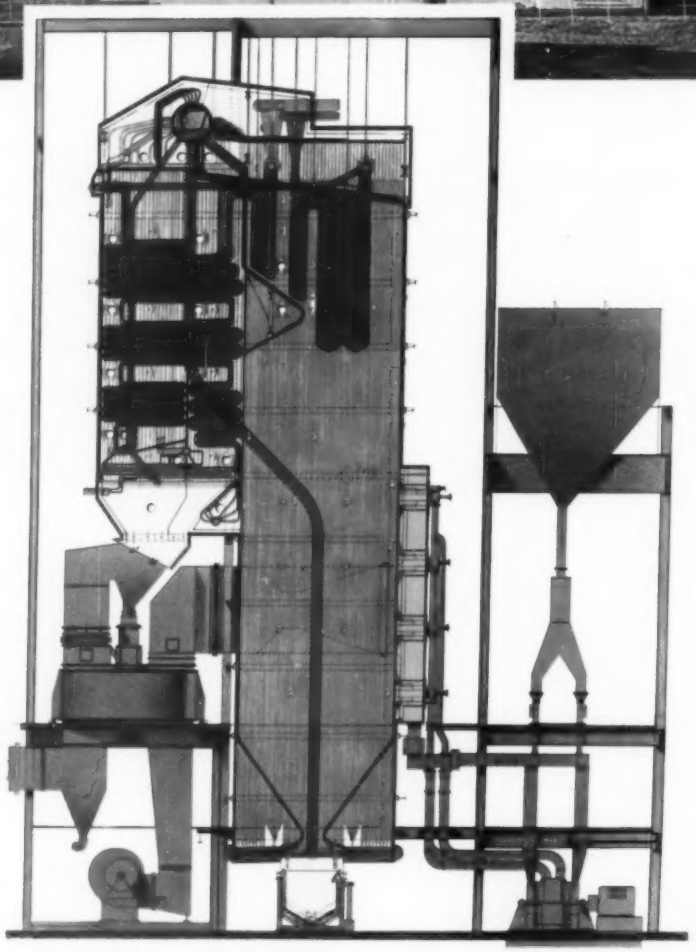
MOUNT TOM POWER PLANT

Holyoke Water Power Company

Mount Tom Power Plant, paradoxically located in a region rich in ancient geological formation and prehistoric lore, is a symbol of modern American engineering achievement. The Riley Boiler is one of the most northern boilers in New England featuring outdoor construction.



Mt. Tom Power Plant's Complete Riley Reheat Coal Fired Boiler
Steam Capacity — 950,000 lbs/hr
Superheat/Reheat Temp. — 1000/1000 F
Pressure at Boiler — 1950 psig
Fired by low grade strip mine coal pulverized in four Riley Duplex Pulverizers.
Sixteen Riley Burners.

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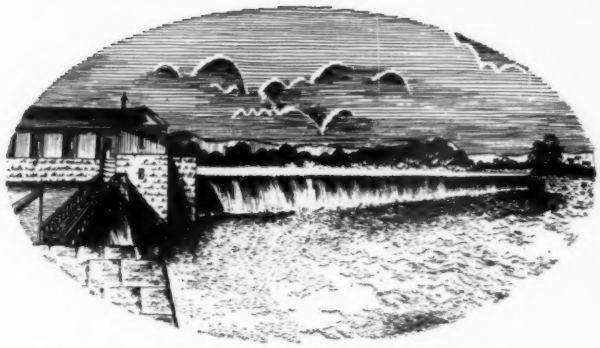


Holyoke Water Power Company Installs a 950,000 lb/hr RILEY Outdoor Type Reheat Boiler at Mt. Tom

Over a century ago Holyoke Water Power Company built a dam across the Connecticut River and a network of canals that provided power for the industries that made Holyoke, Massachusetts famous as a leading New England industrial center. Mt. Tom Power Plant located on a choice site for furthering industrial development can carry on this tradition for years to come. The new steam-electric plant with its capacity of 137,500 kilowatts brings Holyoke Water Power Company's total generation to 229,000 kilowatts. The Mt. Tom plant also supplements existing steam and hydro-electro facilities and provides a dependable source of power when hydro-electric power is reduced by insufficient river flow. Water for the 950,000 lb/hr Riley boiler comes from two never-failing wells at the plant site.

JACKSON & MORELAND, INC.
Consulting Engineers

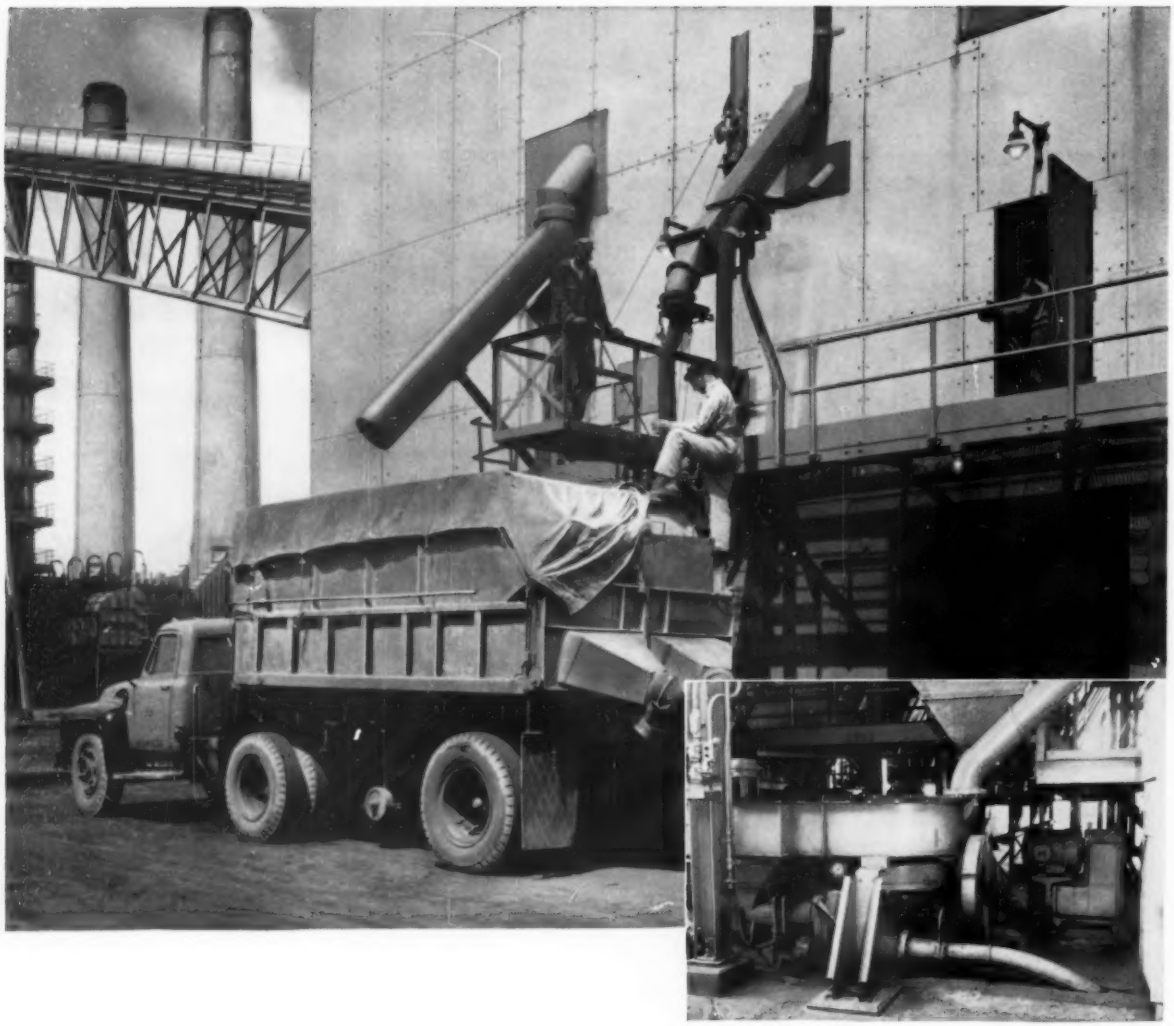
Four Riley Pulverizers efficiently pulverize over 1300 tons of high ash content coal per day. A high degree of fineness is continuously maintained by long wearing tungsten carbide faced pulverizing elements. Operation is vibrationless and quiet. Flash drying feature permits use of unusually wet coal.

Riley offers a complete line of boilers from package unit sizes to the largest central station types. The Riley line of fuel burning equipment offers a wide selection for solving virtually any fuel burning problem. Before you make any decision on new facilities talk to your Riley Representative.

A careful survey of your plant by a qualified consulting engineer could show ways of making substantial savings in power costs.

RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT



Public Service Electric and Gas Co. Turns Fly Ash Problems Into Profit

By using Fuller pneumatic conveying systems, the Sewaren Generating Station of Public Service Electric and Gas Company, New Jersey, was able to collect 4100 tons of fly ash during 1957. Not only did this eliminate a serious disposal problem that formerly contributed heavily to operating costs . . . it also gave the utility which sold the collected fly ash, a new and valuable source of income.

The Fuller-Kinyon system at Sewaren collects and carries the fly ash to two storage silos that have a combined capacity of 380 tons. It is then either bagged in 50-lb. lots or transferred in bulk through a Fuller loading-out silo spout to tank trucks or covered dump trucks. Labor and equipment costs are kept at a minimum. Dusting is avoided, and high tonnages are handled easily over considerable distances. Extra handling flexibility is provided by a Fuller two-way diverting valve that permits unsuitable fly ash to be pumped directly to an ash reject tank instead of to storage.

Fuller pneumatic conveying systems can be installed almost anywhere at minimum costs, regardless of plant conditions. Moisture and dirt cannot enter the system and material cannot escape. Write today for detailed information in Bulletin FF-49-1. 1334 G-202

"See Chemical Engineering Catalog for details and specifications".

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Subsidiary of General American Transportation Corporation

FULLER COMPANY GENERAL AMERICAN TRADE MARK

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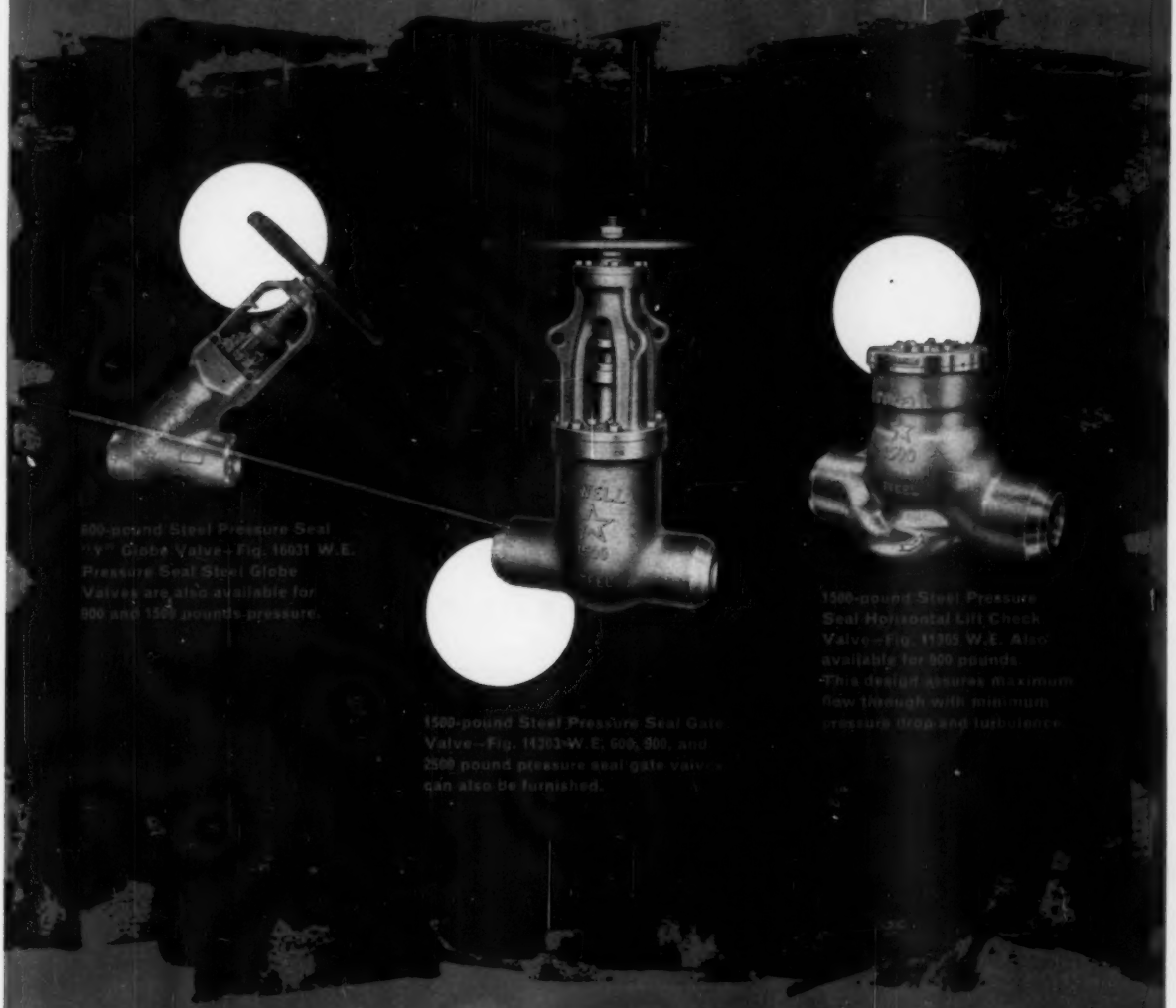
POWELLFUL PERFORMANCE!

Powell pressure seal valves have been proved to control high temperatures and pressures in modern industries. More than 10,000 Powell pressure seal valves in installations on many continents have proved themselves to be precision-built, precision-tested, precision-performing.

This is just another example of Powell's unfailing quality as leading industrial valve supplier of the world. Let Powell's 115 years of valve manufacturing experience go to work for you.

So always look to Powell to solve your valve problems and fill your valve needs. Talk to the Powell valve distributor in your city. Or contact The Wm. Powell Company—TODAY!



600-pound Steel Pressure Seal "Y" Globe Valve—Fig. 16031 W.E. Pressure Seal Steel Globe Valves are also available for 900 and 1500 pounds pressure.

1500-pound Steel Pressure Seal Gate Valve—Fig. 14303 W.E. 600, 900, and 2500 pound pressure seal gate valves can also be furnished.

1500-pound Steel Pressure Seal Horizontal Lift Check Valve—Fig. 11305 W.E. Also available for 900 pounds. This design assures maximum flow through with minimum pressure drop and turbulence.

115th year of manufacturing industrial valves for the free world

POWELL PRESSURE SEAL **VALVES**

THE WM. POWELL COMPANY CINCINNATI 22, OHIO

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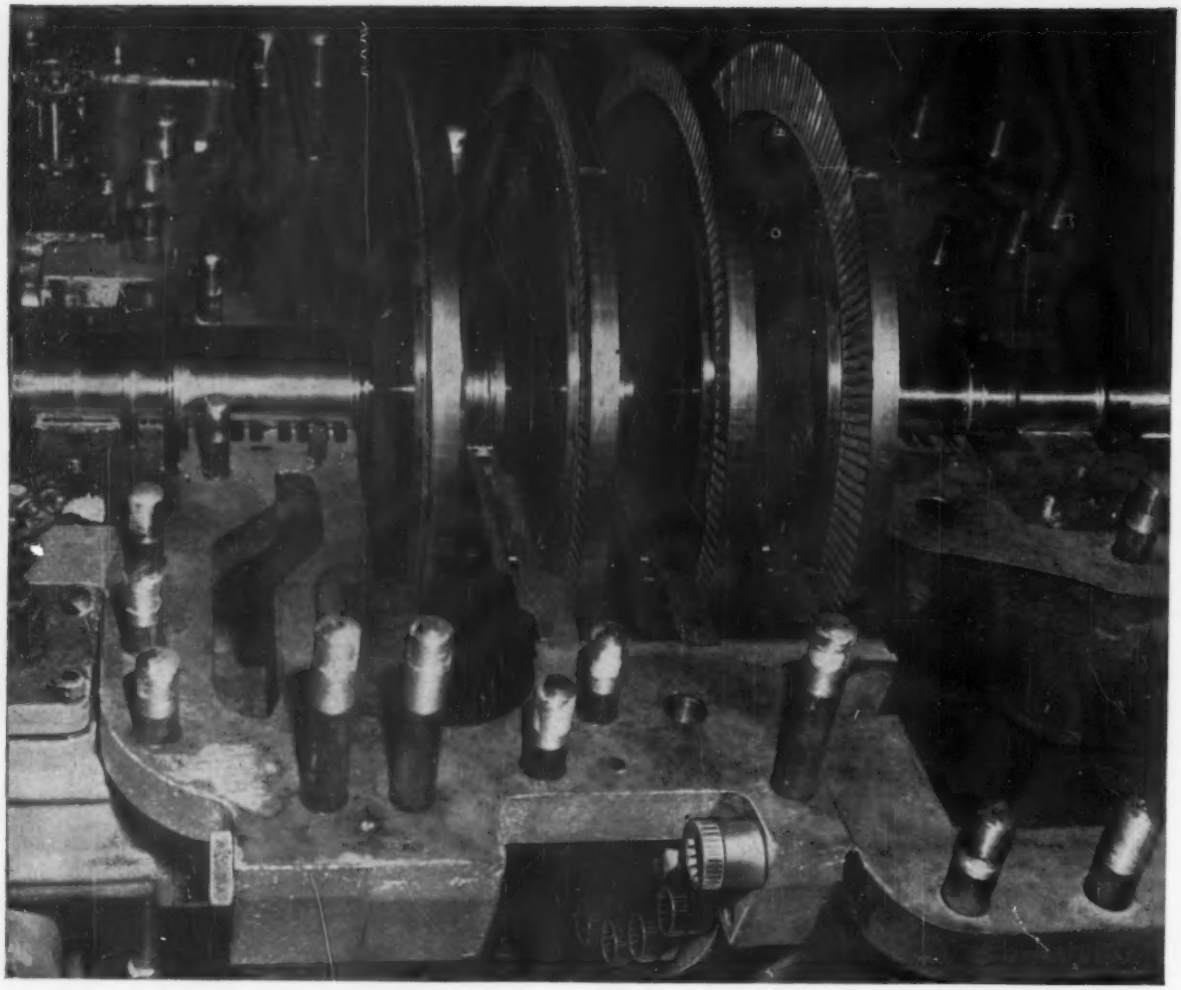

THE INSIDE STORY OF A MURRAY HIGH SPEED COMPRESSOR

DRIVE TURBINE REVEALS THE REASONS FOR MURRAY'S UNIVERSAL ACCEPTANCE

A look at MURRAY'S rugged construction from the inside shows the husky shaft and heavy accurately formed discs with generous sized hubs designed to withstand the axial and radial stresses imposed by this type of service.

Large-dimension disc rims receive the specially contoured stainless steel blades with the Murray integral shroud. This insures smooth steam passages with maximum strength.

Short bearing spans insure smooth operation and eliminate the hazard of operating in critical speeds.

A look at the heavy flanges and husky bolting in the actual unretouched shop photo shown above bears out the extreme ruggedness that typifies every feature of Murray construction.

Our nearest representative will gladly help you solve your high speed compressor drive turbine requirements. Just write to Murray Iron Works Company, Burlington, Iowa, for his name.

Murray
TURBINES

MURRAY IRON WORKS COMPANY • BURLINGTON, IOWA
Builders of Steam Power Equipment for Nearly a Century

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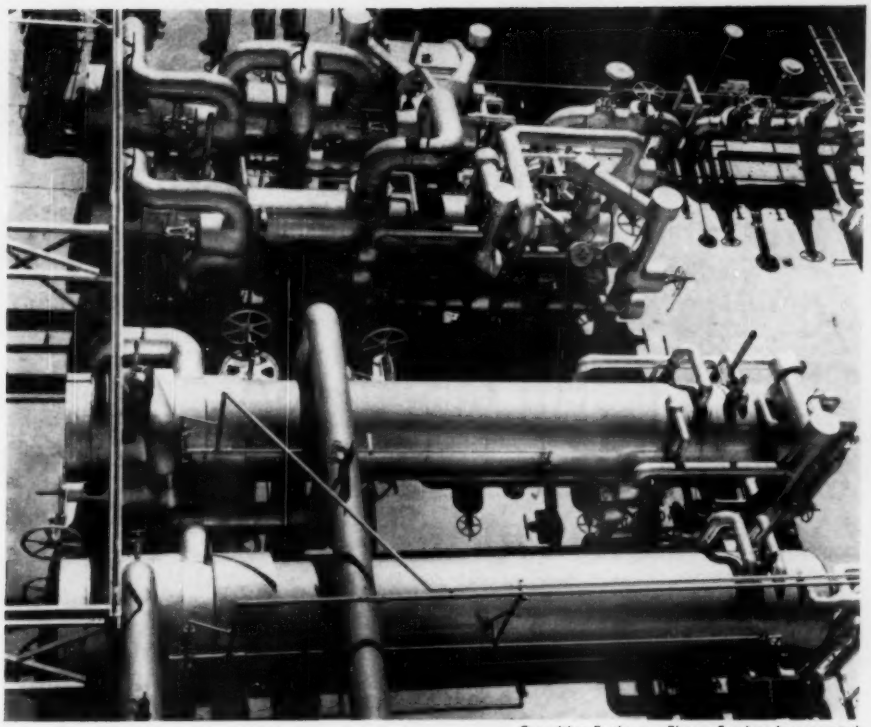

Consulting Engineers: Ebasco Services Incorporated

4,000 PSI 1,000 °F (OR EVEN HIGHER WHEN YOU NEED IT!)

FEEDWATER HEATERS WITH YUBA'S EXCLUSIVE MULTILOK CLOSURE are capable in basic design of operating at the extreme pressures and temperatures required more and more by the power industry.

The Multilok Closure, a Yuba exclusive, is one of the important reasons why these units operate so efficiently and safely in the 4,000 PSI, 1,000° F range. And Yuba is prepared to produce units to handle even higher pressures and temperatures when needed. A pioneer in all-welded design, Yuba offers both all-welded and bolted construction – a complete and versatile line of feedwater heaters for high and low ranges, for every type of job. When space is a critical factor, as many as three low pressure stages can be combined in a single shell for a highly compact unit.

You'll want to discuss both design requirements and costs with Yuba heat transfer engineers during plant planning stages. The scope of Yuba designs will offer the best solution to your particular problem.

Other Yuba products for steam power plants include condensers, evaporators, expansion joints, tanks, bridge and gantry cranes, structural steel erection, and scores of other items.

YUBA

specialists in power plant equipment

YUBA HEAT TRANSFER DIVISION

YUBA CONSOLIDATED INDUSTRIES, INC.

SALES OFFICES IN PRINCIPAL CITIES

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new Yarway Unit Tandem Valve for blow-off service up to 665 WSP . . . gives you the same time-proven dependability of the famous 1500 and 2500 WSP Yarway Unit Tandem design. Streamlined, light in weight, easy to operate, tight sealing, with minimum maintenance.

Ask for free Bulletin B-435, Supplement A

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TIGHT
Sealing valve is time-proven Yarway Seatless design.
TOUGH
Blowing valve features stellite-faced disc and integral stellite seat.
TRIM
Both valves, mounted together, permit more compact piping with reduced weight.

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Current Catalogs

Electrical

101 Maintaining Electrical Equipment — Maintenance and inspection practices to foretell and prevent failure for different types of electrical industrial equipment are described by Associated Research, Inc. in 52-pp Manual D-62. Illustrated by graphs, tables and photos, it contains comprehensive data on methods and instruments for voltage breakdown tests and for measurement of insulation leakage at high voltage. Includes procedures for predicting equipment life.

102 Medium Transformers — Up-to-date information on General Electric Co.'s Permalex transformer insulation system designed to give higher continuous kva loadability is presented in 24-pp Bulletin GEA-6108D. Compares dielectric strength of untreated kraft paper with that of cyanoethylation processed Permalex, and gives ratings of oil immersed and Pyranol transformers.

103 Rebuilt Transformers — GEA-7108, 8 pp, illustrated, describes process of rebuilding distribution transformers at savings. Contains chart of average life span of transformers and description of the Permalex transformer insulation system — standard on distribution transformers rebuilt by General Electric Co.

104 Integral Distribution Centers — Twenty-pp Publication GEA-6928A discusses advantages of General Electric Co.'s new dry-type integral distribution centers featuring quiet, high temperature dry-type transformers for applications up to 5000 v. Describes space saving benefits, construction features. Contains step-by-step ordering information along with tables of ratings, dimensions, weights, prices.

105 High-Voltage Distribution — Equipment and practices for high-voltage distribution are covered in two bulletins released by Line Material Industries, McGraw-Edison Co. Bulletin 60118 includes application data on arresters, cutouts, transformers and insulators and Bulletin 60119 includes construction drawings and bill of materials for typical line poles and transformer and capacitor.

106 Heavy Duty Feedrail — Featured in 32-pp Bulletin 80, released by Feedrail Corp., are heavy duty trolley busway electrical distribution systems for electrification of heavy duty cranes and hoists, machine tools, conveyor assembly lines or other moving equipment that must be powered. Installation details and specifications included.

107 Neoprene Wire, Cable — This wire and cable casebook (1st Quarter 1960) describes properties and applications of Neoprene as a jacketing and insulating material for wire and cable. Electrical properties are given with performance details by E. I. du Pont de Nemours & Co., Inc.

108 Controlled Reclosers — Two oil circuit reclosers with electronic control are described in Catalog Bulletin CR1WE offered by Line Material Industries., McGraw-Edison Co. It includes application, design features, operating features, specifications and dimensional information.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 87 and 88.

109 Starting Equipment—High voltage starting equipment for full and reduced voltage starting and reversing of squirrel cage, synchronous and wound rotor motors is featured in Allen-Bradley Co.'s 36-pp Publication 6080. Covers construction details, performance, ratings, applications and specifications.

110 Synchronous Motor Control — Low voltage synchronous motor starting is covered by Allen-Bradley Co. in 12-pp Publication 6092. Detailed information on synchronous motor control and equipment is included along with photos and diagrams.

111 Secondary Control Switchboards — Bulletin GED-4239, 24-pp, gives information on General Electric Co.'s switchboards, benchboards and control desks with applications for unit generator and transformer circuits, generator circuits, power transformer circuits, transmission and incoming line equipment, feeder equipments and others. Features, dimensions, components and advantages of basic-circuit construction are detailed.

112 Current Limiting LV Breakers — Advanced design features of K-Don current-limiting circuit breakers are detailed by I-T-E Circuit Breaker Co. in 10-pp Bulletin 4300-1A. The line combines 200,000-amp interrupting capacity with complete range of operation of K-line low voltage circuit breakers. Selection and application tips, dimensions and guide specifications are provided in catalog. A graph shows Amp-trap let-through curves.

113 Relay Conversion Kits — Featured in this 8-pp bulletin are Clark Controller Co.'s color selective conversion kits for modifying standard relays. Includes color location diagrams and detailed information on selection of conversion kits.

114 Control Pilot Devices — GEA-7302, 8-pp, describes General Electric Co's control pilot devices including pressure and vacuum switches, pressure governor, plugging and anti-plugging switches, float switches, pilot switches and manual reversing switches. Measurable advantage of each are listed with rating and nomenclature charts, photos, diagrams and list of accessories.

115 Electrical Products — Connectors, receptacles, switches and lighting products for industry are described by Joy Mfg. Co. in Bulletin B81. Illustrations, specifications, applications for electrical connectors, descriptions of lighting products (lamps, sockets connectors, push-button switches in 2, 4 and 6 button and toggle-switch styles) and portable and stationary cable vulcanizers are included.

Mechanical Power Transmission

116 Motorized Drives—Performance details on motorized drives manufactured by Howell Electric Motors Co. are presented in 6-pp Bulletin MD-1. Describes a full line of gearmotors and coupled speed reducers, and includes selection tables showing output speeds for each horsepower rating.

117 Shaft, Flange Mounted Drives — Design and construction advantages of shaft and flange mounted drives are detailed in this 36-pp Bulletin 7100 by The Falk Corp. Operation and selection information is included along with dimensional data and diagrams and photos of application possibilities.

118 Variable Speed Drives — Eight-pp Bulletin 551, of Graham Transmissions Inc., gives information on where and how to use an infinite range, variable speed drive of high accuracy. Principles of operation are given, and special controls for a variety of speed control systems are described with ratings and dimensions.

119 Flat-Belt Pulley — Bulletin 22103, offered by T. B. Wood's Sons Co., covers "Sure-Grip" flat-belt pulleys in face widths from 2½ to 12 in., 3 to 36 in. OD. Straight and crown face types are available from stock. Bulletin lists dimensions, illustrates mounting arrangements, explains how interchangeable bushings offered full range of bore sizes.

Hose and Fittings

120 Flexible Hose, Duct — Bulletin 605, 12 pp, covering Flexaust hose and Portovent duct, The Flexaust Co. provides selection and installation information as well as prices. A chart aids in selecting proper types for a variety of services. Accessories and prices are also covered.

121 Teflon Hose Assemblies — Bulletin TC-46 describes hose and reusable fittings with a core of Teflon, stainless steel wire braiding made by Anaconda Metal Hose Div., The American Brass Co. Gives construction, properties, full engineering data, assembly instructions.

Instruments and Controls

122 Power Plant Control — Illustrated and described in 12-pp Bulletin E-88 is The Cooper-Bessemer Corp.'s En-Tronic control system for starting, synchronizing, switching, computer controlling, regulating and shutting down generating units automatically. Advantages of the system are detailed and component features and equipment are described.

123 Packaged Controls—Bulletin GEA-6334A, 8-pp, describes General Electric Co's. Pan-A-Trol panels for use with pumps, materials handling equipment, air conditioning, and other equipment. It explains product features, reliability and how panels are designed and tailored for specific control needs. Photos show devices

used in the control unit — contactors, starters, relays, switches, timers, terminal boards and push buttons.

124 Process Controls — Bulletin 10, 8-pp, describes Robertshaw-Microsen closed-loop, all-electronic process control systems, capacitance actuated level detection and control instruments, and Vibraswitch malfunction detectors. Contains specifications for all Robertshaw process control instruments, describes their functions and tells how individual instruments and groups of instruments are used. Bulletin by Aeronautical and Instrument Div., Robertshaw-Fulton Controls Co.

125 Photo-electric Control — Eight-pp Bulletin IB-2 is offered by Cramer Controls Corp. describing an infra-red photoelectric control, Infrabeam, which functions by reflected or interrupted beam over long range. Typical materials handling, counting, inspection and control installations are illustrated with specifications and descriptions of models and accessories.

126 Sensing Device — Described in Yarnall-Waring Co.'s Bulletin RI-1825 is a leakproof sensing device for detection and control of process variables. Advantages and applications are detailed and operation principle of wire in tube described.

Safety

128 Impervious Graphite Disks — The four types of impervious graphite rupture disks are described by Falls Industries, Inc. in 8-pp Bulletin 315-2. Includes data on venting capacities, gasket sizes, bolt torque specifications and installation.

129 Safer Sight Gage — Described in 6-pp Bulletin B-58 of PresSure Products Co. is a high-pressure, high-temperature sight glass offering a safety factor of 10 plus. Tells how this glass works, discusses installation and materials of construction, and includes engineering information.

Pumps, Compressors

130 Industrial Pumps—Power driven pumps, variable capacity pumps, proportioning systems, strainers, hand pumps, and others manufactured by Blackmer Pump Co. are illustrated and described in 8-pp Bulletin One. Includes preliminary selection guide for power pumps, lists references to other literature available on each product line.

131 Pump Selection Catalog — Included in 12-pp, easy-to-use Circular 184, published by Dean Brothers Pumps Inc., are charts showing the recommended temperature and pressure ranges for 10 classifications of company's pumps — from −350 F to +1000 F, and up to 1000 psig. Illustrations and specifications are included.

132 Priming/Centrifugal Pump — Described in Bulletin 70215 is Ingersoll-Rand Co.'s Motorpump combining a vane-type priming pump with a conventional high-efficiency centrifugal pump. Includes sketches of pipe-pump-tank layouts, performance curves and dimensional data.

133 Screw Type Pumps — Rotary screw-type pumps for petroleum and process industries; power hydraulics; fuel, lubricating oil, and seal oil applications; viscous and fire-resistant fluids are discussed and illustrated in 42-pp Bulletin 3200 available from De Laval Steam Turbine Co. Selection guide, specifications, tables of performance data, dimensions, viscosity and advantages are included.

134 Controlled Volume Pumps — Motor-driven controlled volume pumps with interchangeable packed or diaphragm liquid ends are illustrated and described in Milton Roy Co.'s 30-pp Bulletin 553-2. Includes selection data guide, materials selection charts and capacity-pressure selection tables.

135 Vertical Compressors — Vertical air or gas compressors standardized for 125 psi in sizes 50 to 2000 hp are described by Bury Compressor Co. in 8-pp Bulletin V-100. Covers packaged compressors to 973 cfm for belt or direct drive.

136 Packaged Air Compressors — Illustrated and described in 6-pp Bulletin 203 by Clark Bros. Co., Div. Dresser Industries, Inc., are air cooled packaged air compressors for industrial applications. Longitudinal and transverse cross sections with callouts highlighting construction features are included, along with weights and specifications.

Boilers

137 Water-Tube Boiler — Twelve-pp Bulletin 586 A describes the Modulatic, a compact, vertical water-tube boiler produced by Vapor Heating Corp. It is designed to generate clean, dry steam at the touch of a button. Discusses operating principle of the unit, automatic control, firing arrangements. Several installations are pictured, and dimensions and specifications provided.

138 Boiler Check List — This check list offered by Cleaver-Brooks Co. is designed to give tips on keeping a boiler clean and operating efficiently. Tells how to rate boiler and obtain better performance.

Water Management

139 Water Processing — The chemistry of coagulation applied to effective water treatment in municipal and industrial plants, practical approaches to problems, and solutions are discussed in 8-pp illustrated Bulletin A-1, by Nalco Chemical Co. Application of sodium aluminates; refined montmorillonites; cationic, anionic and non-ionic polymers; and "inline clarification," are described.

140 External Regeneration — The practice of externally regenerating ion-exchange units in condensate scavenging systems is the subject of Graver Water Conditioning Co.'s 12-pp Technical Reprint T-182. Discusses advantages of internal condensate purification in high pressure central stations, and points out reliability and economy of such external regeneration.

141 Testing Steam Purity — Bulletin 163 describes Barnstead Still & Sterilizer Co.'s Bantam demineralizer with disposable resin cartridge for boiler plant operators to use ion-exchange resins in steam purity testing. The cartridge is of inert plastic and filled with cation resin in the regenerated state ready for use.

Valves, Piping, Fittings

143 Ductile Iron Valves — Twelve-pp Catalog 1 gives details on designs, weights and dimensions of iron valves and fittings available from Stockham Valves & Fittings. Includes comparison charts, engineering specifications and information on prices, terms and deliveries. Also deals with comparisons between ductile iron and other materials.

144 Iron Body Valves — Detailed information on iron body bronze mounted valves and accessories made by American Valve Mfg. Co. is presented in 16-pp Catalog 60. Specification diagrams and dimension tables are included on gate valves with screw ends, flanged ends and hub ends, and swing checks with screw and flanged ends.

145 Ductile Iron Valves — Advantages of ductile iron valves are detailed by The Ohio Injector Co in 12-pp Form 1011. Illustrates and describes spread flange design and includes detailed engineering specifications and application data.

146 Sliding Gate Valves — Eight-pp Catalog J170-1 contains complete engineering data on OPW-Jordan Corp.'s sliding gate and plate control valves. Gives applications, operating features and characteristics, materials of construction, pressure and temperature limitations, flow curves, sizing charts and specifications.

147 Lubricating, Servicing Valves — Rockwell Mfg. Co.'s Bulletin V-218 Rev 2, 8-pp, describes proper method of lubrication for Rockwell-Nordstrom lubricated plug valves, correct adjustment of valves; repacking of Hypreseal valves, etc. It includes a chart of lubricants, and describes lubricant dispensing equipment.

148 Line Strainer Guide — Bulletin J-LS, of OPW-Jordan Corp., presents strainer facts needed by those who specify them. Shows steam and liquid strainers available in aluminum, stainless steel, cast iron, bronze and cast steel. Gives strainer tips for better performance, recommended meshes and engineering details including particle retention capability and charts showing ratios of screen open area to inside pipe area.

149 Cast Couplings—Permanent cast couplings for cast iron or asbestos-cement pipe are illustrated and described by Smith-Blair, Inc., in 12-pp bulletin, Form 216. Covers cast insulating couplings for electrolytic conditions, couplings for repairing broken and deflected pipe, and transition and reducing couplings, others.

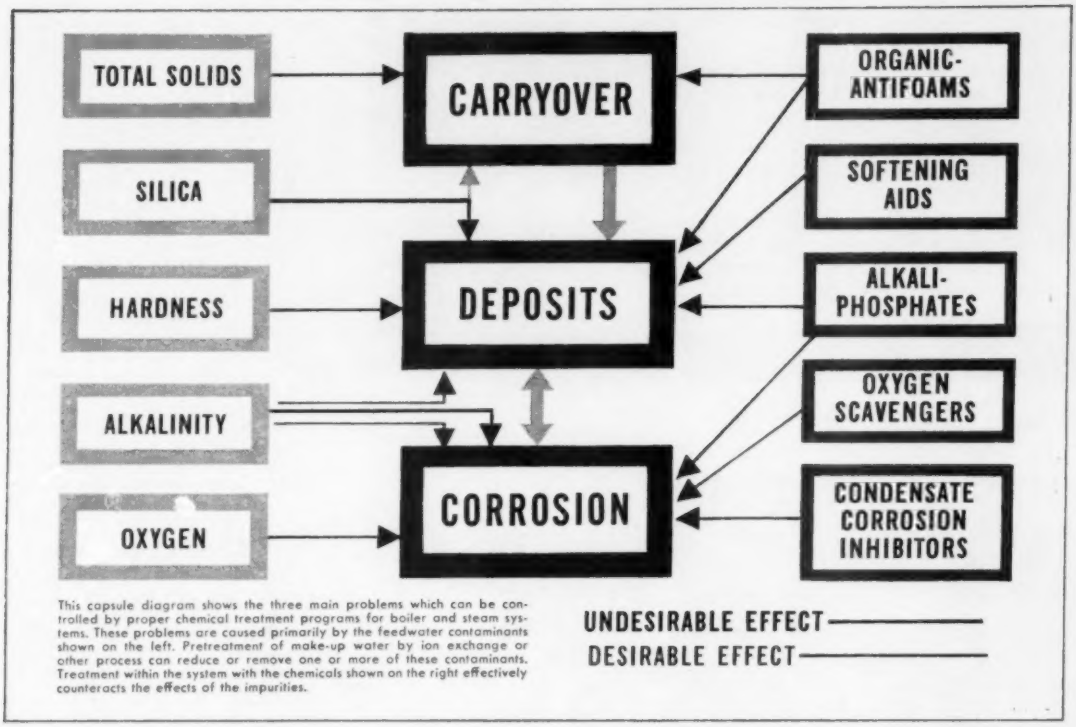
> When ordering catalogs, allow time for us to relay your requests to the manufacturers — and for them to mail out copies. Remember, manufacturers are often swamped with catalog requests.

150 Band Clamps, Couplings — Catalog 803, 44 pp, contains product information on band clamps, hose clamps, couplings, flanges and V-band joints for many applications. While offered especially for design engineers, this catalog of Marman Div., Aeroquip Corp., features products also used in industrial replacement applications. Provides comprehensive dimensional and operating data, as well as installation suggestions.

151 Ball Joints — How to provide for movement and flexibility in metal piping with simple ball joints is detailed by Barco Mfg. Co. in eight-section Catalog

BOILER WATER TECHNOLOGY...

Simplified Diagram of a Complex Problem... And Some Suggestions for Getting Satisfactory Answers



This capsule diagram shows the three main problems which can be controlled by proper chemical treatment programs for boiler and steam systems. These problems are caused primarily by the feedwater contaminants shown on the left. Pretreatment of make-up water by ion exchange or other process can reduce or remove one or more of these contaminants. Treatment within the system with the chemicals shown on the right effectively counteracts the effects of the impurities.

All boiler water treatment is aimed at preventing pickup of impurities by water, removing the impurities, or counteracting their effects. This simple statement of the jobs water treatment has to do gives no hint of the millions of manhours and dollars spent in research, testing and field experience – a great deal of it by Nalco – in efforts to reach these goals dependably and economically in all types and sizes of steam systems.

Your water treatment program should fit your particular needs

There are countless combinations of chemicals, equipment and methods for effectively treating boiler feedwater. Yet there is *one* combination that will prove to be the best for *you*.

It is the responsibility of Nalco people to know and understand all the possible approaches to the prevention of corrosion, deposits, and carryover. But their greater responsibility is to couple this technical understanding with a practical understanding of your particular needs.

That is why the Nalco Representative you call in will, first of all, determine the *quality* of water your plant needs. Whether it is merely hardness reduction, or complete demineralization, chances are his technical ability will enable him to develop a number of ways to produce it. But, most important – he has the practical understanding to know *which* of those methods is the most efficient and economical – *the most practical method* – for you.

A Nalco Program Based on Results

A Nalco program of water treatment for your plant is based on *all* the elements which affect results: chemical, mechanical, and operating factors. To do this, Nalco field personnel bring the full weight of unexcelled water treatment research and development, vast field experience, and specialized training and skills into use to recommend a program with one aim: the lowest overall cost *consistent with best results.*

Once established, your water treatment program includes regular checks by your Nalco Representative . . . Nalco believes that water treatment responsibility is continuous – and the thousands of Nalco-treated plants, many of them Nalco customers without a break for thirty years and more, are ample evidence that this belief works well in practice.

For prompt action on a Nalco program for your plant, call your Nalco Representative today or write:

NALCO CHEMICAL COMPANY
6234 West 66th Place • Chicago 38, Illinois

Subsidiaries in England, Italy, Mexico, Spain, Venezuela and West Germany
In Canada: Alchem Limited, Burlington, Ontario

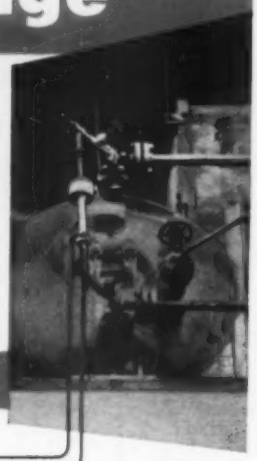
Nalco® ... Serving Industry through Practical Applied Science

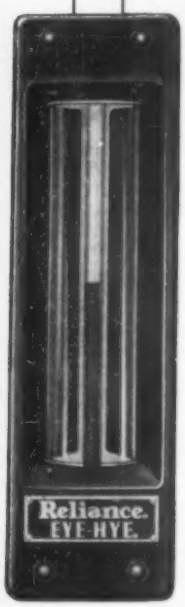
Nalco CHEMICALS
Nalco SERVICES

For more data circle 517 on Post Card

Why a remote reading gage

- Most boiler drums are high – direct gages are far from operating floor.
- Obstructions often make gages hard to see – necessitate special equipment or frequent climbing to inspect.
- Remote gage saves thousands of steps, hours of valuable time. Brings gage reading *down to eye level* at safe distance from boilers.





Why Reliance EYE-HYE

- EYE-HYE assures perfect measurement, dependability and clear reading.
- All-hydrostatic principle – no mechanical parts – no adjustments on location.
- Reads in liquid, like a conventional gage, but easier, faster because of illuminated green indicating fluid.
- Oldest practical remote gage – over 13,000 in use – on land and sea.
- Economical special attachment actuates supplementary alarms, audible or visible, if desired.
- Available for either wall or panel mounting, new wide-visibility EYE-HYEs are made for any pressure range – up to 3000 psi. Also long window model for unusual liquid level variation – for tanks, heaters, etc.

Write for catalog information on EYE-HYE for *your* boiler pressure.

The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland 3, Ohio

Reliance® BOILER SAFETY DEVICES

For more data circle 518 on Post Card

250. Illustrations of the five basic motion principles of ball joints serve to explain safe flexibility in piping subject to contraction and expansion.

152 Pipe Thawing — Data on fast, safe thawing of frozen water pipes with low voltage electricity is contained in Hobart Brothers Co.'s 8-pp Bulletin EW-243. Types of equipment and methods of thawing are covered and table showing amperes and time required included.

Heating and Heat Exchanging

153 Double Pipe Exchangers — Installation and maintenance of double pipe heat exchangers is described by Brown Fintube Co. in 8-pp Bulletin 120. Cross-sections identify parts for easy assembly and tips on cleaning simplify maintenance.

154 Steam Heating Coils — Application information on blast heating, distributing tube heating and dual feed distributing tube coils are detailed in this 24-pp Catalog 1710 available from Sturtevant Div., Westinghouse Electric Corp. It is complete with photos, drawings, construction details, selection, performance, piping diagrams, installation procedures, range of sizes and capacities of coils.

Other Equipment

155 Self-Cleaning Steam Condensers — Reverse flow self-cleaning steam condensers of C. H. Wheeler Mfg. Co. are featured in 8-pp Catalog W-503. Explains the reverse flow principle, describes problems of condenser cleaning, and lists typical installations.

156 Glass-Protected Stacks — Features and advantages of glass-protected smokestacks are described in A. O. Smith Corp.'s 8-pp Bulletin SS-210. Includes comparative maintenance figures, photos of typical installations, tables of weights, basic stack sections, protective glass coating, operating temperature ranges, assembly and erection.

157 Chemical Cleaning — Data Sheet 557 issued by Chas. Pfizer & Co., Inc., covers the subject of chemical cleaning with citric acid solutions. Advantages of ammoniated citric in chemical cleaning are fully detailed.

158 MV Lamp Manual — This 28-pp technical booklet of Westinghouse Electric Corp. contains latest information on most phases of mercury vapor lamps including light output, life ratings and electrical and physical characteristics. Also describes lamp construction, designations, color rendition and auxiliary equipment. It discloses increases in initial light output of many mercury lamps and contains a section on applications. Covered are industrial lighting, floodlighting, lighting of buildings.

159 Mineral Wool Insulations — Spun mineral wool felts and bonded mineral wool blankets are described by The Eagle-Picher Co. in these two bulletins. They discuss composition of the insulations, tell where to use them, stress efficiency, economy and other advantages offered. Information on sizes, densities included. The Eagle-Picher Co.

160 Improved Wire Rope — Bulletin 60100 describes 7-Flex, a new wire rope design consisting of seven rope strands helically laid around a core. The rope's

Now...new from Bailey

...a "foolproof"

FLAME DETECTOR

that rejects flames from other burners

Flame detectors are sometimes "fooled" by glowing refractories or flames from burners adjacent to that under surveillance. This new Bailey Flame Detector *responds only to the flame it surveys* . . . assures positive monitoring of coal, gas, oil or combination fuel-fired furnaces. Absence or failure of flame is sensed and accurately signaled—or relayed to control auxiliaries—without use of external relays or amplifiers.

Here are other distinctive features that make this new Bailey Flame Detector outstanding:

Wide temperature range . . . is suitable for use in areas with ambient temperatures from -20 to +300° F. Flame sensing element withstands temperatures up to 600° F.

Easy inspection . . . quick disconnect, keyhole mounting simplifies checking of lens condition and detector alignment.

Simple, solid-state circuitry . . . Bailey Flame Detector unit contains only 8 components.

Weatherproof construction . . . design of Bailey unit makes it suitable for outdoor installation.

Why not have your Bailey Engineer give you more information? Call the Bailey district office, or write us.

A147-1

Instruments and controls for power and process

BAILEY METER COMPANY

1040 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

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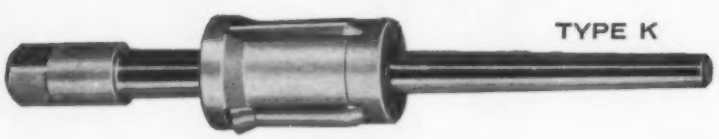
write for your copy of this Bulletin!

ELLIOTT
Boiler Tube Expanders
for tubes 3/4 in. I.D. and up



This 16-page bulletin describes general types of Elliott boiler tube expanders for fast, efficient tube rolling jobs. It also gives dimensions, prices and other descriptive data and shows various drum, header and short series mandrels which are used with Elliott boiler tube expanders. Drum mandrels are seen with Type M and Type K above.

Accessories available to adapt Elliott boiler tube expanders to various tube rolling applications include universal joints and extension shafts, sockets, gear drives, etc. A new heavy-duty, right-angle gear drive utilizes roller bearings to minimize friction, cutting down power losses.

RIGHT-ANGLE GEAR DRIVE▸
Available in ½, ¾ and 1-in. sizes

Write the Elliott Company, Lagonda Division, Springfield, Ohio, *today*, for your copy of Bulletin Y-46.

Y7-5

ELLIOTT COMPANY
GENERAL OFFICES: JEANNETTE, PENNSYLVANIA
PLANTS AT: Jeannette and Ridgway, Pa.; Springfield, Ohio; Newark, N. J.
TURBINES · GENERATORS · MOTORS · COMPRESSORS · TURBOCHARGERS
DEAERATING HEATERS · EJECTORS · CONDENSERS · STRAINERS · TUBE CLEANERS

For more data circle 520 on Post Card

flexibility, fatigue resistance and ruggedness are explained and illustrated by Macwhyte Wire Rope Co.

161 Industrial Bucket Elevators — Engineering data on various types of bucket elevators and recommendations of belting best suited for elevating materials of different weight, abrasiveness, temperature and other characteristics are given by Hewitt-Robins Inc. in 22-pp Bulletin 174. Selection procedures, statistical tables on steel elevator buckets, trouble-shooting chart included.

162 Silencer Selection — This bulletin of Silence, Inc., is a condensed design manual on methods for handling the problem of noise generated by gas flow devices. Acoustic criteria to be met are discussed, and acoustic and aerodynamic characteristics of the various types of Silentflow silencers are described. Design charts aid in selecting proper type and size silencer.

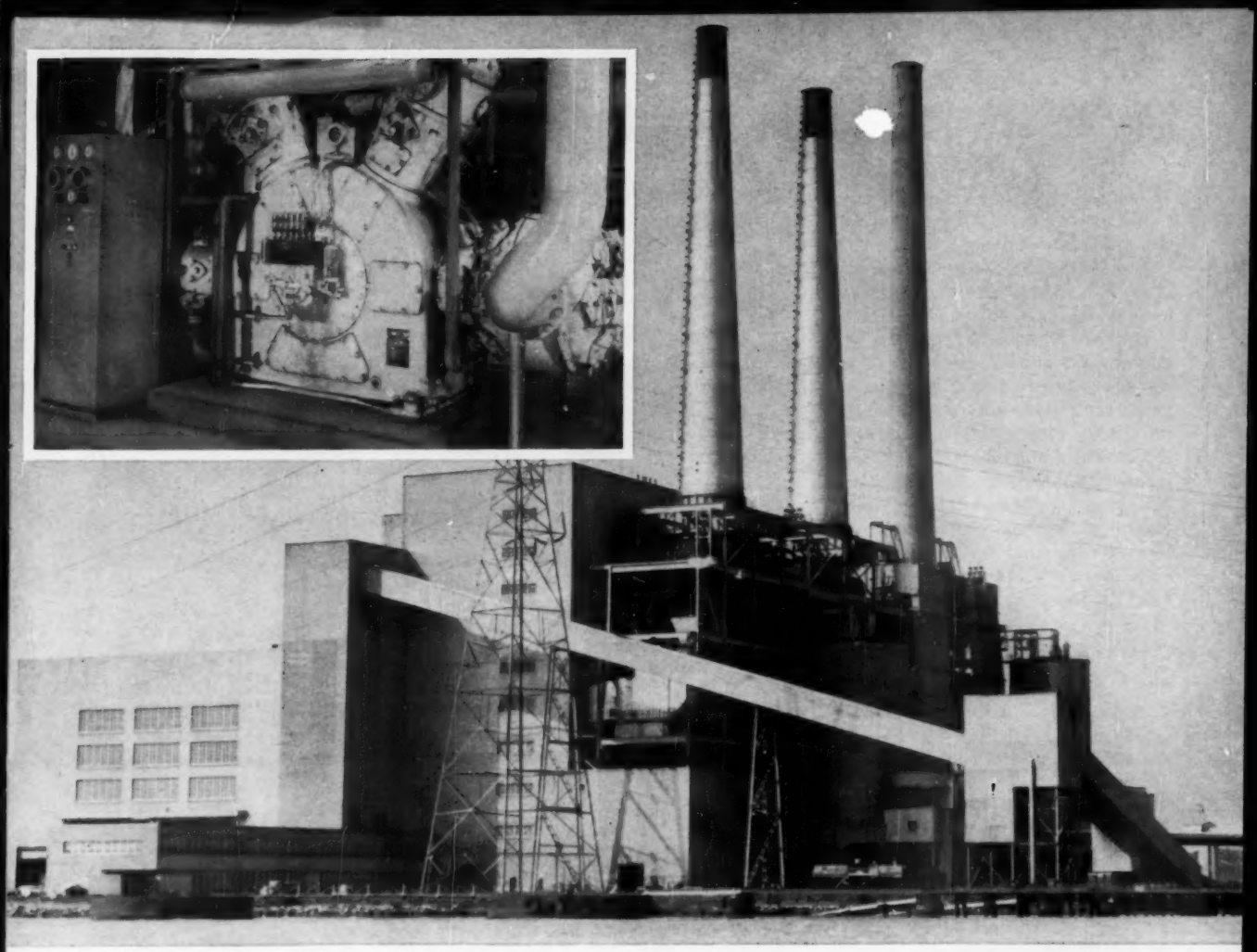
163 V-Type Engines — Details on Cooper-Bessemer V-type four-cycle engines for driving generators, pumps and compressors under sustained high-horsepower operation are given in Bulletin LSV-77-2. Specifications and dimensional drawings are included.

164 Hydraulic Products—These three recent catalog sections deal with a wide range of hydraulic products of Formrite Tube Co., their application and pertinent design data. The 31-pp tube and fitting section covers tubing advantages, company's fabrication facilities, typical applications, specific product capabilities, tube forming procedure and design suggestions, standard tooling data. The hose section, 12 pp, provides material relating to adapter unions, general information on hose-to-tube assemblies, hose and thread specifications, suction line data. The 16 pp third section gives detailed data on hydraulic tube fittings (SAE 37-deg flare, JIC steel). Formrite Tube Co.

Catalogs reviewed here are offered primarily for qualified power engineers. Manufacturers may withhold literature from persons who do not state their job title and company. Some manufacturers also prefer not to send literature to those in foreign countries in which they have no sales representative.

165 Protective Coatings — Corrosion and deterioration problems are discussed in Bulletin T-97-61, 8-pp, on Bitumastic coatings by Koppers Co., Inc. Tar Products Div. It covers properties and specification data on nine products, and typical installations requiring corrosion protection with the recommended coating. The coatings are designed to meet specific problems — underground corrosion, water exposure, corrosive atmospheres, chemical and mechanical destruction of steel, etc.

166 Temperature Conversion Chart — This temperature conversion chart, issued by Rosemount Engineering Co., permits rapid, accurate conversion from any scale — Kelvin, Rankin, Centigrade or Fahrenheit — to any other scale. Range is from absolute zero to 16,000 C. Chart is printed on both sides, punched for three-ring binder.



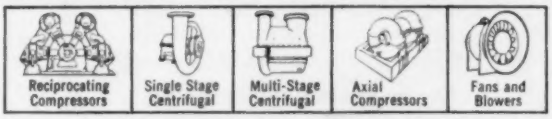
MODERN JOY WH-234 COMPRESSOR SUPPLIES 300 LB. SOOT BLOWING AIR AT DETROIT EDISON'S RIVER ROUGE PLANT

A Joy WH-234 Semi-radial Compressor was installed at the River Rouge Plant to provide additional 300 pound soot blowing air when a huge 321,500 KW turbine-generator was added in 1957. The new unit gave the River Rouge Plant a total installed capacity of 841,500 KW, making it one of the largest power plants in the country.

Joy's modern semi-radial construction provides a compressor which is both rugged and compact. Floor space requirements are less than for any other type of compressor of comparable capacity, yet valves are easily accessible for inspection and maintenance. Truncated piston design gives high compressor efficiency by reducing head clearance to a minimum—cutting re-expansion loss. Like all Joy compressors, the WH-234 features replaceable cylinder liners and crosshead guides, force-feed lubrication and rugged construction throughout for long, maintenance-free service life.

Consult your Joy representative for complete details on Joy high pressure compressors for soot blowing, or write for Bulletin 2554-56C.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



JOY

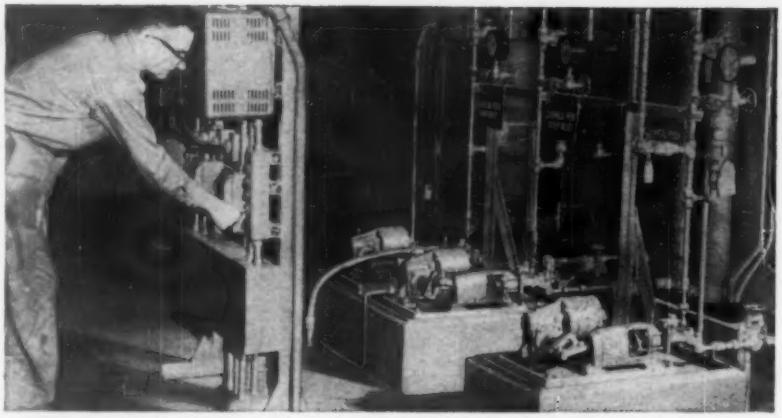
Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

For more data circle 521 on Post Card

how to select the right metering pump for water treatment

SOFTENING, demineralizing, pH control, oxygen scavenging . . . all of the treatments commonly applied to water place special demands on chemical feed systems. Chemicals must be metered to a high degree of accuracy, but many of them, particularly the strong acids and alkalies, are themselves highly corrosive. Through the years, controlled volume pumps have proved the ideal metering technique in this field, combining accuracy, controllability, and corrosion resistance. But the question often arises, "Which controlled volume pump design is best for my water treatment needs?" Here are a few practical suggestions based on actual experience.



Standard Milton Roy MD pumps meter ammonium hydroxide to maintain desired boiler feedwater pH at Ohio Power Company. Milton Roy miniPumps also feed minute amounts of hydrazine to remove residual oxygen from feedwater at this generating station.

PUMP SELECTION GUIDE

FOR	USE THIS PUMP TYPE
Coagulation	
alum	MD
silicate	MD
Demineralization	
acid regeneration	Diaphragm / Mersemetric
alkali regeneration	Diaphragm
Softening	
conc. phosphoric acid	Diaphragm
conc. sulfuric acid	Diaphragm / Mersemetric
lime slurries	MD
phosphates	MD / H20
soda ash solution	MD
Oxygen Scavenging (Boiler Water)	
sodium sulfite	MD / H20
hydrazine	MD / miniPump
Calcium Precipitation (Boiler Water)	
phosphates	MD / H20
Carbon Dioxide (Boiler Water)	
neutralizing amines	MD / H20
filming amines	MD / H20
pH Control (Boiler Water, Process Water, Cooling Towers)	
caustic soda	Diaphragm / Mersemetric
sulfuric acid	Diaphragm / Mersemetric

Packed plunger pumps . . . MD, H20®, miniPump®

The standard Milton Roy MD pump is usually the first choice for metering water treatment chemicals. Highly accurate, its capacity is readily varied manually or automatically in response to treatment demands. A wide variety of materials of construction from cast iron to stainless steel withstand all mildly corrosive treatment chemicals. Capacities to 2056 gph, pressures to 1000 psi. *Bulletin 553-1.*

Non-corrosive chemicals can be metered economically with the H20 pump if constant speed operation is satisfactory. Though it cannot be adjusted in operation, this low cost pump is ideal for feed to packaged boilers. Capacities to 28 gph, pressures to 600 psi. *Bulletin 558-3.*

When extremely small volumes of chemical, from 20 to 2940 milliliters per hour, must be metered to accuracies of 1%, the Milton Roy miniPump is the right answer. That's why this design is just about standard for metering hydrazine in oxygen scavenging. Pressures to 1000 psi. *Bulletin 1257-2.*

Diaphragm liquid ends

The best pump for highly corrosive or otherwise dangerous treatment chemicals is the diaphragm pump, with a stainless steel or plastic diaphragm isolating the plunger from the treatment chemical. Positive air purging at each stroke eliminates any chance of air binding. And the diaphragm liquid end is readily interchangeable with the packed plunger liquid end of the standard MD pump, permitting economical modernization in the event of a change in metering requirements. Capacities to 400 gph, pressures to 2700 psi. *Bulletin 1157-2.*

Totally immersed liquid ends . . . Mersemetric®

Many special metering problems are easily solved by Mersemetric controlled volume pumps with the liquid end submerged to a depth of up to fourteen feet. Chemicals can be metered directly from storage tanks without any need for tank connections below liquid level. Mersemetric pumps are widely used to feed sulfuric acid to cooling tower water and deaerator effluent, and sulfuric acid or caustic soda for demineralizer regeneration. Capacities to 218 gph, pressures to 1200 psi. *Bulletin 1153C.*

If precision pumping of boiler water treatment chemicals is one of your problems, look again to Milton Roy's 25 years of experience for your most economical solution. Milton Roy Company, 1300 East Mermaid Lane, Philadelphia 18, Pennsylvania.

milton Roy
CHEMICAL INSTRUMENTATION SYSTEMS

Controlled Volume Pumps • Quantichem Analyzers
Chemical Feed Systems • pH Instruments

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ATOMICS

A section of POWER ENGINEERING covering current and forthcoming developments in the field of Nuclear Power throughout the world

ANDREW W. KRAMER

Editor

CONTENTS

Untermyer's Neutron Telescope 33

We have had optical telescopes for some 350 years. Within the last decade we have seen the development of the radio telescope. Now comes Sam Untermyer of General Electric with his neutron telescope, a device for measuring the steam output of a boiling-water reactor. Read about it on this page.

Damage to, and Repair of the HRE-2 Core Tank ... 34

An account of an extremely difficult repair job, one that had to be done by remotely manipulated special tools in the presence of radiation in excess of 100,000 r/hr.

Plan for Maintenance of Insulation on Containment Structures

By H. H. Norden 37

This is the first part of a two-part discussion of a plan for the maintenance and repair of the insulation on nuclear plant containment structures. This first part indicates the method of attack. A second article will present details of its practical application

G-E and N.Y. Utilities to Build Superheat Reactor 38

First Scottish Nuclear Power Station Takes Shape

By F. C. Livingstone 39

Hunterston Nuclear Generating Station at Hunterston, Scotland, has virtually been completed and is scheduled to be on load for the winter of 1962–63.

New Nuclear Literature 40

UNTERMYER'S NEUTRON TELESCOPE

ONE OF THE MANY interesting papers presented at the American Nuclear Society meeting in San Francisco in December was one by Samuel Untermyer describing a neutron telescope. This is a simple device for measuring the steam output of a boiling-water reactor from a point external to the reactor itself. A number of these devices have already been installed on the Dresden Nuclear Reactor.

Strange as it may seem, a monitor external to the reactor can measure small differences in the steam output of various boiling reactor fuel channels. Untermyer's neutron telescope does this by determining the attenuation of a narrow fast neutron beam passing from the reactor core through the steam-water mixture above the core.

The device was first tried out on VBWR, the Vallecitos Boiling-Water Reactor of the General Electric Co. In the experimental setup, a Hornyak button detector was arranged to view neutrons collimated in passing through a hole in the steel radiation shield above the top of the reactor pressure vessel. The detector was set to discard low energy scattered neutrons, so that the device saw primarily unscattered fast neutrons. In this test, the telescope focused on an area about 5 in. in radius when looking through the steel vessel from a distance of 22 feet.

If P is the power density at the point where the neutron beam originated, α the exit steam void fraction, λ the attenuation distance in the non-boiling coolant, and T the top reflector thickness, then, according to Untermyer, the counting rate of the detector is proportional to

$$Pe\,\frac{\alpha T}{\lambda}$$

Since in practical cases the exponential term dominates, steam voids above the core are roughly proportional to the logarithm of the detector output, so the detectors are very sensitive to small changes in reactor conditions.

The author presented calibration curves which were obtained by operating the reactor with various water depths without boiling. Using these curves it was possible to determine the power output of the reactor from the counting rate of the neutron detector above the reactor with a considerable degree of accuracy.

The simplicity of this device, and the ease with which it may be mounted completely external to the reactor should make this instrument a useful adjunct to all boiling-water reactor systems. As mentioned previously, they have already proved useful at the Dresden Station.

Andrew W. Kramer

Damage to, and Repair of The HRE-2 Core Tank

Here is an account of an extremely difficult repair job, one that had to be done by remotely manipulated special tools and in the presence of radiation in excess of 100,000 r/hr

HRE-2 is the AEC's designation for the second homogeneous reactor experiment at the Oak Ridge National Laboratory. Like its predecessor HRE-1, it is designed to test the economic feasibility, and work out the problems of power generation within a reactor in which the fuel is dissolved in a liquid moderator which is circulated as a coolant. HRE-1, which embodied a concept proposed by the Oak Ridge National Laboratory, was dismantled in 1954 after operating successfully for two years at the laboratory. HRE-2 was completed in May 1956. It uses for fuel a dilute solution in heavy water of uranyl sulfate, highly enriched in uranium 235.

One important advantage of this type of reactor is that the design is mechanically simple, and it has a high degree of nuclear stability, which makes for safety. Stability of fuel elements over long periods is not a problem, as in reactors using solid fuel rods. The possibility of continuous removal of fission products, many of which act as neutron absorbers, makes this type of reactor attractive as a breeder operating on the thorium-uranium 233 cycle.

The problem of fuel element stability, however, has been solved at the expense of difficulty in containing the highly radioactive and corrosive solution in a high pressure plumbing system. During two years of operation, between January 1958 and February 1960, there were several instances of overheating and severe local corrosion, melting, or burning of materials in the core of HRE-2, and two holes developed in the Zircaloy-2 core tank, the latest in January 1960. The perforated-plate flow diffusers were drastically attacked, as were corrosion specimens and a titanium holder, which were in the core during one run. The diffuser screens are $\frac{1}{8}$-in. Zircaloy-2 plates pierced with $\frac{3}{8}$-in. holes on a $\frac{1}{2}$-in. triangular pitch.

These incidents occurred while the reactor was being operated with some uranium separated from the circulating fuel solution and with at least a part of the separated material in the core. Overheating from fissioning in deposits on the metal surfaces caused the drastic corrosion and burnout. There is evidence that such difficulties can be overcome by changes in the hydrodynamic design of the core and adjustment of the composition of the fuel.

From the safety standpoint, experience with the HRE-2 assembly has (1) emphasized the importance of the relation between core design and properties of the fuel in fluid-fuel reactors, (2) confirmed that Zircaloy-water and titanium-water reactions involving massive pieces of metal are not normally self-sustaining, (3) provided further demonstration of the effectiveness of the negative temperature coefficient in controlling nuclear excursions in aqueous homogeneous reactors, and (4) emphasized the importance of knowledge of the distribution of fissionable material and careful control of inventory in fluid-fuel reactors.

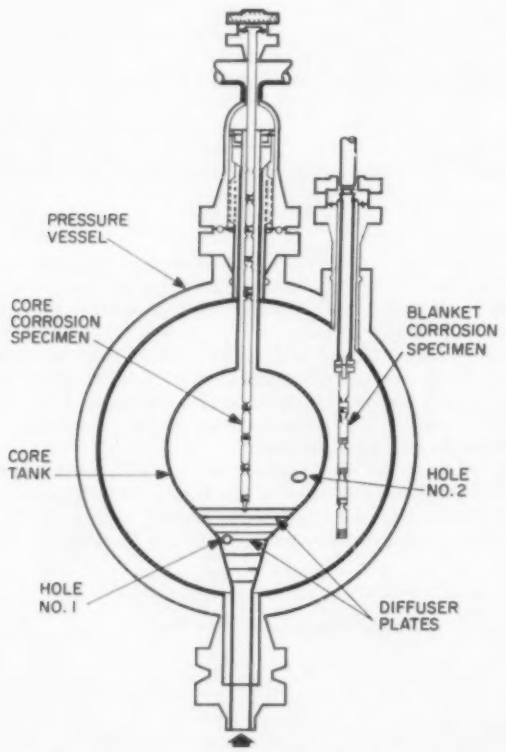

Fig. 1. Diagram of HRE-2 Reactor Vessel

Reactor Details

The HRE-2 is a two region circulating-fuel reactor designed to operate at 5 Mw(t) at temperatures up to 300 C and pressures up to 2000 psia. The reactor vessel assembly, including corrosion specimens in the core, is shown schematically in Fig. 1. A heavy-water solution of uranyl sulfate is recirculated upward through the core at the rate of about 450 gpm. The design fuel solution composition is 0.04 M UO_2SO_4, 0.02 M $CuSO_4$, and 0.025 M H_2SO_4. The copper catalyzes the recombination of radiolytic gas, and excess acid increases the stability of the fuel against separation of uranium by hydrolytic processes. Initially the blanket contained only heavy water, which was recirculated at a rate of about 250 gpm. The first hole[1] permitted communication between the core and the blanket, and the reactor therefore was operated most of the time with uranium in both core and blanket regions.

The first hole occurred during run 14 on April 4, 1958, about 30 min after the power had been raised to the nominal design level for the first time.[2] The actual heat-balance power level was 6.4 Mw. The reactor had been operated for a total of 989 hr, 257 critical, and approximately 400 Mw-hr since the first critical experiment.[3] The initial indication of the incident was a decrease in the fuel level in the fuel circulating-system pressurizer. This was followed by changes in the letdown-valve position, storage-tank weight, and other indications that there was transfer of fluid from the core to the blanket system. Analyses of samples of blanket fluid confirmed the transfer. The only obvious change in the nuclear behavior of the reactor was a gradual increase in the amount of power generated in the blanket, and therefore the power level was lowered by the operator.

Locating the Trouble

The reactor was subsequently shut down in the normal manner by gradually diluting the fuel and the cooling system. Evidence that the hole was in the core tank at the junction between the 30° and 90° conical sections, as shown in the diagram, was obtained in a few days, but it was in a region where it could not be viewed with the simple periscopes available at the time. It was suspected that the weld at the junction between conical sections had cracked.

Although the reactor was still operable and was operated with fuel solution in both regions, it became necessary to determine the cause of the failure, to alter the operation so that further failures would not occur, and to repair the damage. Flow tests and calculations indicated that better flow conditions would be obtained at the core wall if the diffuser screens in the conical entry were removed and the flow reversed to travel from top to bottom.

Access to the vessel, as shown in the diagram, is through a 2-in. diameter pipe on the vertical axis and 7 ft above the equator of the vessel. The closest approach is 17 ft above the vessel equator atop the 6-ft thick concrete shield plugs. The radiation within the core vessel after it was emptied was in excess of 100,000 r/hr. The pieces of the diffuser screens that were removed read 120 r/hr, and even the simplest tools used in the core read 10 r/hr upon removal. The hole was determined to be at the intersection of the 30° and 90° cones, at the level of the 5th diffuser, and to be, by optical measurement, about 1.0 by 1.25 in.

Before run 15, procedures were developed for operating the reactor with the concentration of uranium in the blanket only about one third that in the core,[5] making it possible to generate between 40 and 60 per cent of the heat in the core. In run 16 the power level was raised gradually to the 5-Mw level, and operation was continued at this power for several days before the reactor was shut down for inspection and installation of corrosion specimens in the core. Brief surges or "pips" in power were observed during run 16, and there was one pip in which the power increased from 3.8 to 5.6 Mw. The disturbances caused no significant upset in the reactor temperature or pressure. Although tests were run in an attempt to characterize the disturbances, no conclusions were reached as to their cause. The total operating time at the end of run 16 was 2049 hr, 941 hr critical, and 2055 Mw-hr.

Following further unsuccessful attempts to view the hole, corrosion specimens were installed in the core, and run 17 was made. Much of the power operation was at a level of approximately 3.5 Mw. Power pips occurred much more frequently than in run 16, and in one pip the power increased rapidly from 3.5 to 25 Mw as a result of the introduction of an approximately 2.1 per cent change in reactivity in 10 seconds. The resulting pressure surge was about 200 psi. A pressure rise of 1000 psi, which would accompany the introduction of a 10 per cent change in reactivity in about 3 seconds, is the maximum considered to be permissible during experiments with the reactor, and a pressure rise to 3900 psi is considered to be dangerous.

Two of the three thermocouples installed in the corrosion specimen holder, one near the bottom and the other near the center, indicated rapid changes from the normal temperature to a temperature in excess of 1000 C at times not associated with power pips, and then they failed. Tests made at the time suggested that the abnormal behavior was due to sheath failure. The third thermocouple, which was near the core outlet, indicated normal temperatures throughout the run.

Correlation of analyses of samples of fuel solution showed that uranium separated from the fuel solution as the power increased and that the amount separated was approximately proportional to the power level, at least in the range of 1 to 3 Mw. The maximum power-dependent loss of uranium was about 1.5 kg. Comparison of the inventory based on analysis of the fuel and the inventory based on a relation between fuel concentration and critical temperature indicated that at least a part of the separated uranium was in the core and was effective in promoting the nuclear reaction. Run 17 was terminated after about six weeks for inspection of the core.

Inspection showed that the specimens in the core had become loose from the holder and had fallen on the screens. The ends of the specimens

Fig. 2. This photograph shows the second hole and the end of a probing tool

were at least partially destroyed. Attachments to the holder were destroyed, and there were two holes in the webbing of the titanium holder. The two thermocouples that failed had disappeared up to the level of the third thermocouple. The third thermocouple was intact, and specimens in the outlet pipe were intact. Many ligaments were missing from the diffuser plates, and it was discovered later that four of the top five screens had become detached from the wall.

The hole was seen for the first time from outside the core by means of a special arrangement of periscope and mirrors and, from inside the core, after a 2-in. diameter hole was cut through the diffuser plates. The hole was approximately 1 in. in diameter and gives the impression of having been formed by melting of the Zircaloy wall, which was ⅜ in. thick at that point. Metallographic examinations of parts of the specimens and specimen holder and of a small region of a section removed from the upper screen indicated that the metal in areas of severe damage had been heated to a very high temperature, presumably to the melting point. The heat-affected zones were so small and the metallographic structures were of such a nature that the heating and cooling must have occurred in very short times. Presumably the reactions ceased when the driving heat sources were removed as the metal disintegrated.

Several other runs were made, largely to investigate the effect of variables on power level at which an instability was first detectable. The power level for inception of instability was found to increase with decreasing pressure and with increasing activity of the fuel. The reactor operated in a stable manner at 5 Mw and 260 C if the pressure was kept below 1250 psia.

During the experiments the reactor was operated continuously at various power levels for periods of 2 to 3½ months. The second hole, measuring 1⅝ in. long and ⅝ in. across, and the end of a probing tool are shown in Fig. 2. Until the brittle edges were chipped away by the probing tool, the hole was smaller and irregular. This observation led to the possible, but less likely, conclusion that the second hole was caused by corrosion rather than by burnout. The only indication of the incident was a gradual decrease in the average nuclear temperature and an increase in the fraction of power produced in the blanket as the mixing increased. The increased mixing made it necessary to operate with about equal concentrations of fuel in core and blanket, with most of the power produced in the blanket.

In January 1959, a program was initiated to design tools and procedures to remotely cut the diffuser screens loose from the core wall, to remove them from the core vessel and to remotely close the hole through the vessel wall. A saw was devised which could be inserted through a 2-in. pipe and then unfolded to saw on a 7 in. radius to cut a screen loose from the vessel. A miniature underwater Heliarc cutting torch and a manipulator for it were developed. The manipulator can be inserted into the vessel where it will pick up a screen, position it, and cut it into 1.5-in. wide strips. Techniques were developed for removing the strips from the vessel and placing them in a suitable carrier for later transport to a hot cell for metallographic examination.

A tool was built to remotely take a plastic impression of the hole and of the core around it. From this impression a tight-fitting cover plate was made and provided with a crushable gasket of thin wall gold tubing. The cover plate was placed in position and retained by a toggle bolt and the torque on the bolt adjusted to a predetermined load by a manipulator working from within the vessel. Various viewing devices and lights capable of extended use in intense radiation fields were built and tested. All the repair devices were tested and the techniques for their use perfected in a dimensionally accurate mockup of the reactor. The modification and repair work was begun February 27, 1960. By August 1960, the last remote tool was removed from the reactor. Throughout the work there was not a single case of overexposure of personnel to radiation.

Reasons for Failure

The HRE-2 experience has led to the conclusion that difficulties were encountered because of a combination of factors related to the chemical stability of the fuel and the hydrodynamic design of the core. Uranium can separate from uranyl sulfate fuel solutions in several known ways. Solubility of the fuel constituents decreases with increasing temperature, and $UO_3 \cdot D_2O$, $UO_3 \cdot UO_2SO_4$, and $CuO \cdot 3UO_3$ can precipitate, or a heavy liquid phase that is rich in uranyl sulfate and copper sulfate can separate from solution if the temperature gets sufficiently above the design operating temperature. Uranium is sorbed by corrosion-product oxides of zirconium and iron, and there is some indication that the temperature coefficient of sorption is positive. Fuel constituents can be concentrated by boiling on the metal surfaces.

Normally the concentration would be small, but severalfold increases in concentration might be obtained under unfavorable geometric and low flow conditions. Such concentrated fuel is much more corrosive to Zircaloy-2 than the normal fuel, and the corrosion products have been found to contain 10 to 40 per cent bound uranium in some experiments. The two-liquid-phase temperature of the fuel solution decreases with increasing concentration, passes through a minimum, and then rises again. This minimum two-liquid-phase temperature was below the boiling temperature of the fuel at the operating pressure during much of the operation.

In the HRE-2 the flow is sufficiently low so that fuel in contact with some surfaces in a clean reactor might reach the boiling point. This condition is greatly aggravated when corrosion products solids are present. Upward flow with low velocity tends to cause solids to accumulate on surfaces below the equator of the core, and thus to further retard the flow, increase the heating, and promote conditions that lead to fuel instability. Deposits that contain 40 mg of uranium per square centimeter should produce heat at burnout rates. The fact that the flow conditions in HRE-2 were unfavorable in the presence of solids was demonstrated in mockup tests and was at least partially confirmed by examination of the reactor core.

Damage to materials in the HRE-2 core is of considerably less importance than the demonstration that there are ways in which uranium can separate from the fuel and deposit in the reactor system. The large negative temperature coefficient was shown to be effective in limiting the effects of shifting of this material in the reactor to pressure surges which were of little consequence. The amount of reactivity that can be controlled by the negative temperature coefficient is limited, however; and the ratio of uranium in the circulating system to uranium in the core of a large circulating-fuel power breeder reactor can be between 2 and 4. A major consideration in the design of a large plant, therefore, will be control of the inventory so that separation of fissionable material under abnormal conditions can be recognized and remedial measures can be taken before the amount of reactivity associated with the separated uranium is greater than that which can be controlled easily by the negative temperature coefficient.

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ATOMICS

Plan for Maintenance of Insulation On Containment Structures

This is the first of a two-part discussion of a plan for the maintenance and repair of the insulation on nuclear plant containment structures. This first part indicates the method of attack. A second article will present details of its practical application

By H. H. NORDEN

General Electric Knolls Atomic Power Laboratory

IN THE PRESENT stage of atomic power development, and probably for some time to come, it is considered desirable to house the nuclear reactor in a separate containment building, designed to contain the radioactive material that might be released in the event of an accident to the reactor system. These containment structures are essentially pressure vessels of enormous volume, designed around the basic gas laws of physics, and are generally shaped as spheres or as cylinders with spherical or elliptical heads. The outside surface, exposed to the elements, is coated with insulating material, which deteriorates in time. Because of the area involved, replacement of the insulation is expensive. It is the purpose of this discussion to outline a sampling plan, with variations, to determine the condition of the insulation and then propose a method of determining the economic break-even point for the replacement of all or part of the covering.

Background

As already mentioned, these containment buildings are shaped as spheres or as cylinders with spherical or elliptical heads. Most well known of the spherical structures in this country are the following:

1. Atomic Energy Commission Test Facility for Prototype Testing of Naval Propulsion Plants, operated by the General Electric Company at West Milton, New York. Sphere diameter is 225 ft.

2. Commonwealth Edison Company Boiling-Water Reactor (Dresden Plant) to supply the City of Chicago, located at Morris, Illinois. Sphere diameter is 190 ft.

3. Consolidated Edison Company of New York Pressurized-Water Reactor (Indian Point) to supply the City of New York, located at Indian Point on the Hudson River. Sphere diameter is 160 ft. The sphere will be covered by a cylindrical weather shell with an elliptical upper head and open bottom. The outer shell is not designed as a pressure vessel, but will be affected by the insulation problem.

4. Yankee Atomic Electric Company Pressurized-Water Reactor to supply the City of Boston, located at Rowe, Massachusetts. Sphere diameter is 125 ft.

Structures shaped as cylinders are built with the cylindrical axis oriented vertically. The top head is a hemisphere, with a radius equal to the radius of the cylinder. The bottom head, which is generally below ground level, is usually an ellipsoid whose major axis equals the diameter of the cylinder, with the minor axis half of the major axis. Most well-known of the cylindrical structures in this country are the following:

1. Experimental Boiling-Water Reactor (EBWR), operated by the University of Chicago at the Argonne National Laboratories. Diameter 80 ft, over-all height 119 ft.

2. Detroit Edison Company Fast Breeder Reactor to supply the City of Detroit, located at Lagoona Beach, Michigan. Diameter 72 ft, over-all height 120 ft.

3. General Electric Company Experimental Boiling-Water Reactor located at Vallecitos, near San Francisco, California. Diameter 48 ft, over-all height 100 ft.

4. Army Packaged Power Reactor (APPR), designed by the Army and built in quantity by Alco Products Incorporated. A pressurized-water reactor designed to be carried to Arctic and other sites by air, and erected ready for operation in six months. Diameter 32 ft, over-all height 60 ft.

The largest of these structures, the Atomic Energy Commission sphere at West Milton, New York, will be used as an example since the method of insulation attachment is known to the writer in some detail, however the problem is similarly handled on most of these structures. The subject is a sphere 225 ft in diameter, of which 38 ft are below ground level. Set in a concrete "bowl" with a larger radius, the sphere is supported on its hemisphere by 26 columns 74 ft long.

The space between the sphere and the concrete "bowl" is filled with lean concrete, and the underground portion of the sphere is coated with a special paint to permit slippage or movement of the sphere shell. Sand is used in place of concrete near the ground line to avoid a sharp edge against the steel, and to handle surface water seepage. Concurrently the inside of the sphere is filled to ground level with crushed limestone rock which is compacted to maximum density, and covered with a layer of concrete.

All of these structures are built of special steel plate from ½ in. to one inch thick, prefabricated to the proper radius. At the site these plates are welded together with full-penetration welds. On the subject sphere 26,000 continuous feet of joints were welded. All welds are radiographed completely to insure their soundness, with repairs made as indicated by the radiographs.

After all steel work is finished, the exterior is first given a coating of zinc chromate to inhibit rusting. Next a coating of water-proofing mastic is applied. Into this mastic are placed 9 in. by 18 in. foam glass blocks two inches thick. Each block is held in position by two Speedclips slipped over Nelson studs welded to the steel shell. The Speedclips are countersunk into the surface of the blocks. Over the blocks is applied a tack coat of waterproofing into which is imbedded 15-mesh open-woven fibreglass.

Finally, another coating of waterproofing is applied. On a sphere 225 ft in diameter, with 38 feet buried in the ground, a net area of 132,115 square ft of insulation (3⅓ acres) is exposed to the elements. The deterioration of this insulation, with resulting heat losses, varies as a function of the quality of material used, ferocity of the elements at the site, etc. Experience varies widely, with from two to fourteen years reported on some of these structures before the need for repair or replacement is indicated.

Because of the diverse experience on need for repair, and because of the relative inaccessibility of much of the area of these structures for close inspection, a sampling technique is called for to establish the condition of the insulation at any given time. Such a sampling technique will now be proposed.

Sampling Surface Condition

As in any sampling plan, certain preliminary steps are necessary.

A. Size and Condition of the Population.

It has already been established that the exposed surface of the subject sphere is 132,115 square feet. Because of the location of the sphere, it is felt that the entire area is subjected to approximately equal weather conditions.

Of some significance, however, is the effect of snow and rain on the crown area, and the crown should probably be chosen as a separate zone or stratum for evaluation. Other strata might consist of the balance of the upper hemisphere as one zone, and the visible portion of the lower hemisphere as another. Ultimately, however, stratification should be aimed at maximizing homogeneity of heat loss in each stratum.

It should also not be forgotten that in many geographic locations the exposure to particular elements (rain, snow, sun, wind) may cause the insulation to deteriorate at widely differing rates on different sectors of the surface. An objective analysis of this factor should be made. As a rule of thumb, however, any area less than one-third of the total should not be considered as acceptable once it has been established that the balance of the area is to be resurfaced, since such a move would not be economic when considering the relative "fixed costs" in setting up scaffolding, etc, during a resurfacing project.

B. Accuracy of Analysis Required.

Samples of about one square foot of area should be taken. Because of the relative economy of taking samples, especially when compared to the large cost of resurfacing, it is definitely recommended that sufficient samples be taken to establish reasonable 99 per cent confidence limits ($3\ \sigma$) for the total heat loss. The largest single factor affecting sample size is the degree of homogeneity of the heat loss in the zone being sampled.

As the homogeneity of the population of one zone increases, the sample size decreases until, in the ultimate, if the entire population of the zone is identical, then a single sample suffices. If the total surface can be successfully zoned into relatively homogeneous areas, and if the degree of homogeneity can be fairly accurately measured, then the sample size in any stratum can be calculated according to Cochran.[1]

$$n_h \propto N_h S_h \qquad (1)$$

where n_h is sample size, N_h is population size, and S_h is the deviation, all in the $_h$ stratum or zone. In this proportionality, the value of the standard deviation, S_h, will have to be estimated to give optimum allocation n_h. Fortunately, however, an error in the estimate of the standard deviation affects only the optimality property of the sampling but will not bias the result in any case.

The length of confidence interval for the mean heat loss per unit area will diminish as the total sample, $n = \sum_{i=1}^{L} n_h$, goes up. How large we take n will depend upon how short we hope to get the confidence interval since

$$V(\bar{y}_{st}) = \frac{1}{N^2}\left[\sum_{1}^{L} N_h (N_h - n_h)\frac{S_h^2}{n_h}\right] \qquad (2)$$

and, since the confidence interval is just a multiple of the square root of $V(\bar{y}_{st})$, we can get the value of n_h and hence the value of n by requiring the variance of the mean heat loss, $V(\bar{y}_{st})$, to be as small as we want. Substituting the optimum, n_h, equation (2) becomes

$$V(\bar{y}_{st}) = \frac{1}{N^2}\left\{\frac{(\sum N_h S_h)^2}{n} - \sum N_h S_h^2\right\} \qquad (3)$$

which can be solved at once for n. Then from equation (1) we can determine n_h.

It should be remembered that the calculated mean heat loss per unit area, $\bar{y}_i$, must be weighted by the total area, N_i, to arrive at total heat loss; i.e.:

$$N\bar{y}_{st} = \sum_{i=1}^{L} N_i \bar{y}_i \qquad (4)$$

In the event, however, that such an estimate of variance cannot be made accurately, because of inaccessibility for close observation of the surface or for other reasons, the two-sample method by Stein[2] can be recommended. Here the author recommends the taking of a preliminary sample, from which the true strata variances of the population can be estimated; an accurate calculation of sample size required to yield a confidence interval, of arbitrarily chosen length, for the true heat loss per unit area can then be made. A second sample would be taken. It should be noted that the taking of two samples need not but frequently will result in a larger total number of observations than if only one sample were taken by the Cochran method; the advantage of the two stage procedure is that a prescribed length of confidence interval can be achieved.

This, then, indicates the method of attack and the proposed statistical sampling plan to be used in the economic repair or replacement of exterior insulation on reactor containment structures. A subsequent article will present the details of the sampling technique and its cost, and outline an economic break-even analysis to arrive at an optimum replacement evaluation.

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[2] Stein, Chas.; "A Two-Sample Test for a Linear Hypothesis Whose Power is Independent of the Variance"; *The Annals of Mathematical Statistics*; September, 1945, pp 243–259

G-E and N.Y. Utilities To Build Superheat Reactor

THE General Electric Co in conjunction with seven New York State utilities are planning to build an $8-million superheat developmental reactor to help extend the technology of nuclear superheat for eventual application to large-scale nuclear power plants.

The new reactor will be designed, built, and owned by the G-E Atomic Power Equipment Department (APED) at its Vallecitos Atomic Laboratory. The seven New York State utilities have formed a nonprofit corporation known as the Empire State Atomic Development Associates, Inc (ESADA), which will participate in the superheat development program by providing $5,750,000 toward design and construction of the reactor. Members of the ESADA group are Central Hudson Gas & Electric Corp, Consolidated Edison Co of N.Y., Long Island Lighting Co, New York State Electric & Gas Corp, Niagara Mohawk Power Corp, Orange & Rockland Utilities, and Rochester Gas & Electric Corp. The ESADA group is participating in the program as part of its over-all plan for ultimate development, design, and construction of a large 300,000- to 500,000-kw nuclear-electric generating station.

The new reactor, rated at 15,000 thermal kilowatts, will be built alongside the Vallecitos Boiling-Water Reactor, where earlier basic test programs demonstrated the feasibility of nuclear superheat. The superheat reactor will be used to raise the temperature of steam produced in VBWR to levels achieved in conventional modern generating stations.

First Scottish Nuclear Power Station Takes Shape

By F. C. LIVINGSTONE

THE MAJOR PART of the civil engineering work on the two reactor structures and turbine hall for the $115 million nuclear power generating station at Hunterston, Scotland, is now nearing completion.

The station, which will be the first to generate power for public use in Scotland (Dounreay, on the north coast of Scotland, is purely an experimental station for the Atomic Energy Authority), is located on the coast of Ayrshire about 35 miles southwest of Glasgow.

The first reactor is scheduled to be on load for the winter 1962–63 and the second for the fall of 1963. The station will be operated by the South of Scotland Electricity Board.

Each of the reactors is about 180 ft high. The last sections of the concrete biological shield of the first have been lifted into place and the assembly of the 3-in. thick, 70-ft diameter pressure vessel is complete. A start has been made on the erection of the structure to house the service machinery.

Civil engineering operations on the

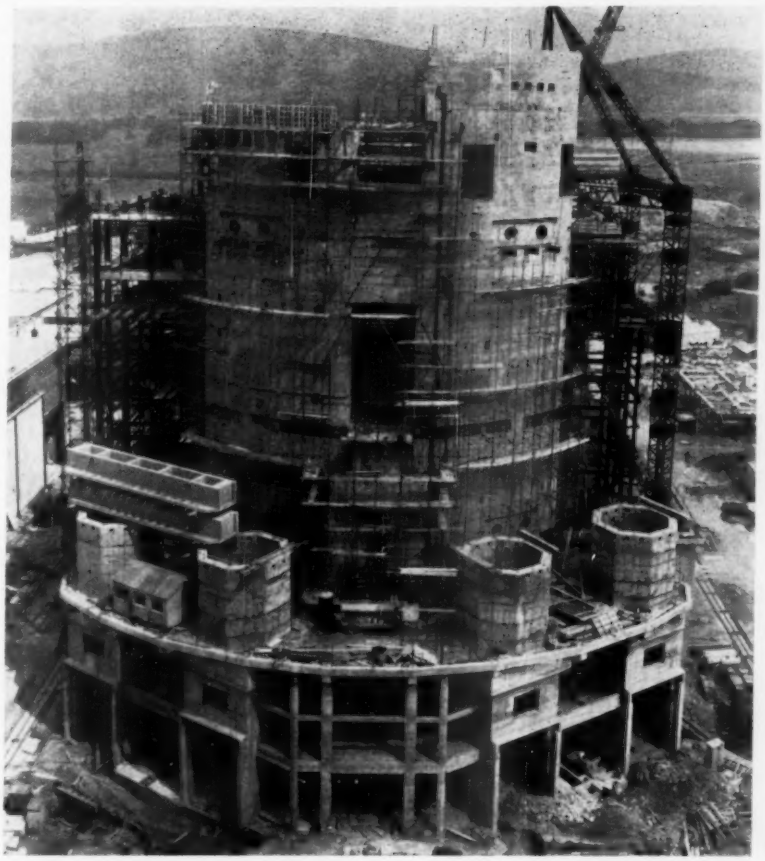
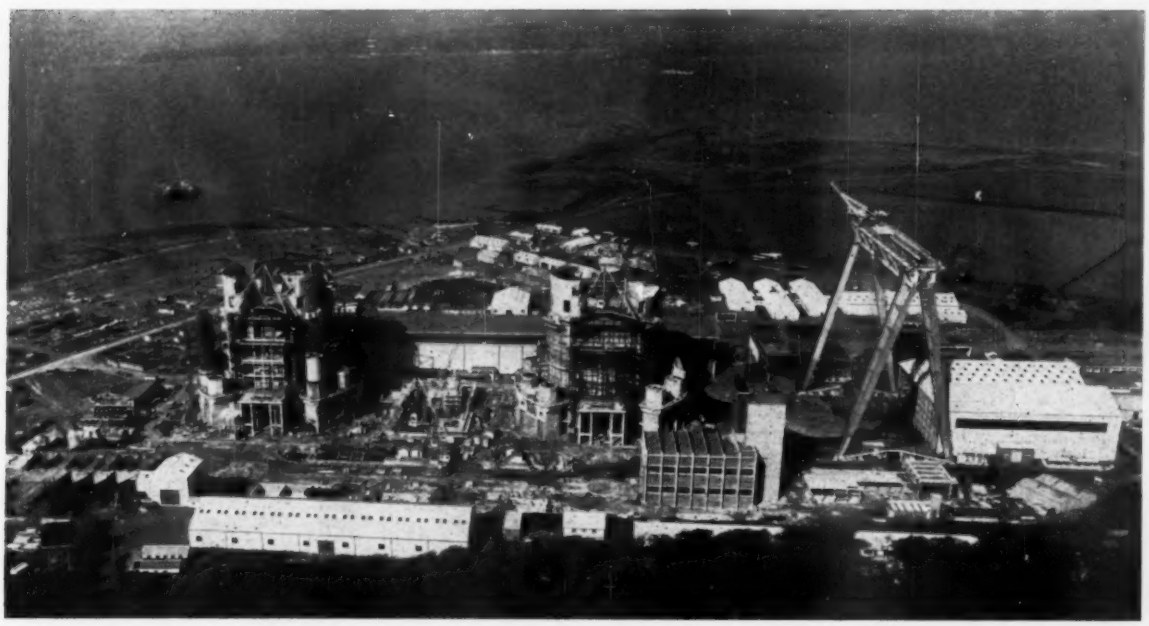


Fig. 1. (Right). A view of the plinths of the steam-raising units of Reactor B at the Hunterston nuclear generating station. Two of the concrete beams that will form part of the soffit of the roof biological shield are shown ready for lifting into place

Fig. 2. (Below). An aerial view of Hunterston Nuclear Generating Station. At the center right is the 300-ton Goliath crane



exterior of the 680-ft long turbine hall have been completed; the six turbine-generator foundation blocks are in position, three of the six condensers are installed, and delivery of the generator sets themselves has now started.

Three 1000-kw emergency diesel generators have been erected in the basement of the turbine hall, for use to supply the power station's essential auxiliary plant should there be a failure of the incoming power supply.

It is now stated that the cost of the station may be $15 to $30 million more than the original estimate of $115 million. This increase will be partly due to the new technical advances, particularly those concerned with safety instrumentation, and partly due to labor strikes, of which Hunterston has had more than its fair share.

The area of the new nuclear station is 110 acres, of which 17 have been reclaimed from the sea. A total of 174,000 cu yd of rock have been excavated, 17,000 tons of steel have been used, and 185,000 cu yd of concrete poured. The weight of each reactor is 80,000 tons, and the station will have an output capacity of 360 Mw (e).

The principal contractors are the General Electric Co Ltd, and the chief engineer is D.W.T. Angwin.

New Nuclear Literature

In these days of rapid technical development it is sometimes difficult to know where one branch of science ends and where another begins. This is particularly true of nuclear science and what has come to be known as solid state physics because in the search for suitable materials the two overlap considerably. This is particularly true in the development of thermoelectric devices for use in connection with nuclear reactors. Designers of small compact nuclear power plants for space vehicles, for example, in which the direct conversion of heat to electricity is brought about by thermoelectric generators, must be conversant with the various new materials available for the design of such generators. Workers in the nuclear field, therefore, will find a new book, *Thermoelectricity*, recently published by John Wiley & Sons, of considerable interest. This book indicates all the new directions for the direct conversion of heat to useful electrical energy. Edited by Paul H. Egli of the U.S. Naval Research Laboratory, it is a collection of papers designed to provide guidance for those scientists and engineers who are, or will be, dealing with problems which the new field of thermoelectricity involves. The volume includes the Proceedings of the Conference on Thermoelectricity, sponsored by the Naval Research Laboratory, September 1958, as well as additional papers that contain reviews and concepts originating during the last two years. The book is divided into four sections. Section I presents an introduction and broad survey of the fundamental concepts of thermoelectricity. The second section examines the physics of the properties which determine thermoelectric performance. Section three deals with the chemical and physical properties of materials at high temperatures, and Section IV, the last section, is devoted to the measurement of material properties. With new sources of heat available and more on the horizon, direct conversion to useful electrical energy has become a problem of national and international importance. Of the several schemes of energy conversion being explored, thermoelectricity appears at present to be the most promising for general use; indeed in several fields of basic sciences, thermoelectricity is making an impact that will overshadow the enormous strides induced by the development of transistors. As indicated by Dr. Egli in the preface, many problems remain to be overcome. The limitations of the band theory of solids will have to be removed. Thermal properties need to be solved in detail; work will be stimulated on the transport properties of solids at high temperatures, and our appalling ignorance about liquids will have to be faced. In chemistry, work on thermodynamics, high temperature phase equilibria, thermal stability, and problems of fabrication will be stimulated. In all the material sciences, thermoelectricity offers a great challenge, and a great opportunity to create new materials with specified properties. *Thermoelectricity* contains 407 pages, is 6¼ by 9½ in. bound in cloth, and is available from John Wiley & Sons, Inc, 440 Fourth Ave, N.Y., at $10.

* * * *

Those interested in or concerned with problems of radioactive waste disposal will be interested in a 90-page report entitled *Radioactive Waste Handling in the Nuclear Power Industry*, recently published by the Edison Electric Institute. This report which was made by the Technical Appraisal Task Force on Nuclear Power of the EEI is quite optimistic in its general tone. For example, the study points out that even if worldwide nuclear power operations increase rapidly, their average radiation will be less than that from natural sources, such as cosmic rays and minerals in the earth, and much less than radiation from medical and dental procedures involving x-ray and isotope treatments. The report also concludes that the amount of radioactive wastes from operation of U. S. nuclear power stations and related fuel processing will not exceed for several decades that which has already been produced and successfully handled in U. S. atomic weapons production facilities. This report, *EEI Publication* No. 60–46, is available from the Edison Electric Institute, 750 Third Avenue, New York, N. Y. Price per copy, to member companies and employees, $2.00. To non-member companies, $5.00. Prices include mailing charges.

* * * *

The production of low-temperature nuclear process heat has become of increasing interest to those working in the nuclear field during the past two years because it is believed that nuclear energy can become competitive with fossil fuel energy in this area sooner than in the utility field. Low-temperature process heat, that is usable heat at temperatures below 380 F, should permit the use of less expensive materials which can tolerate these relatively moderate temperatures. Recognizing the interest in this area of nuclear development and the need for exploring its possibilities, the Atomic Energy Commission on October 1, 1959, conducted an unclassified symposium on the development and potential industrial uses of reactors for the production of low-temperature process heat. This meeting was held at the AEC headquarters at Germantown, Maryland, and was open to the public without restriction. The principal purposes of the meeting were: (1) to present technical and economic information on low-temperature, process heat reactors, and (2) to ascertain from those present the extent of industry interest in participating in the development of such reactors. The Proceedings of this symposium have recently been published and is available from the Office of Technical Services, Department of Commerce, Washington, D. C. The Report is designated TID-7580 and the price is $0.75. Aside from the technical information which this report contains relative to low-temperature heat production, there is in it a most comprehensive analysis of the domestic and process heat requirements in the United States.

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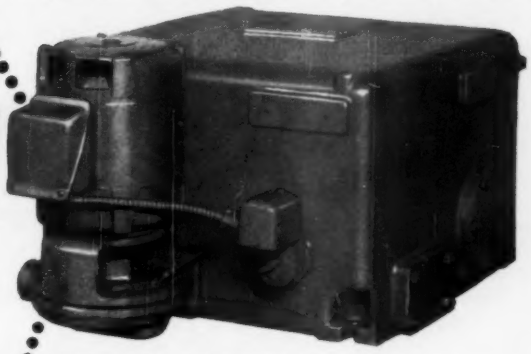

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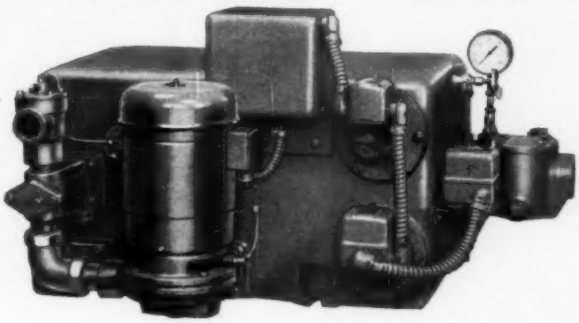

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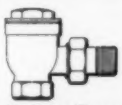

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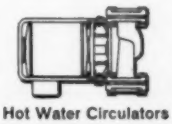

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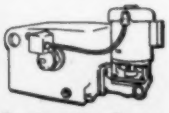

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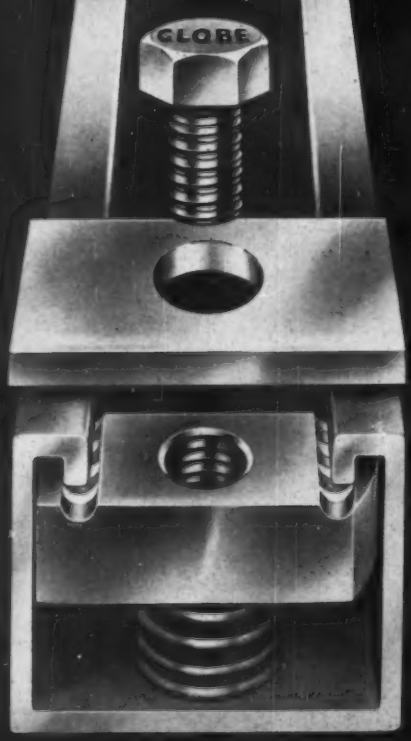

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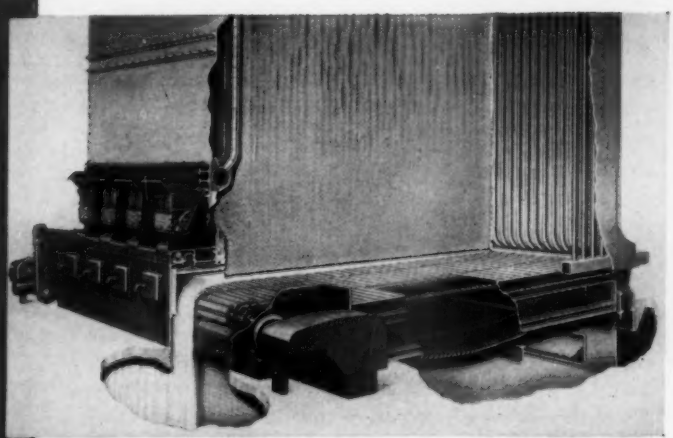

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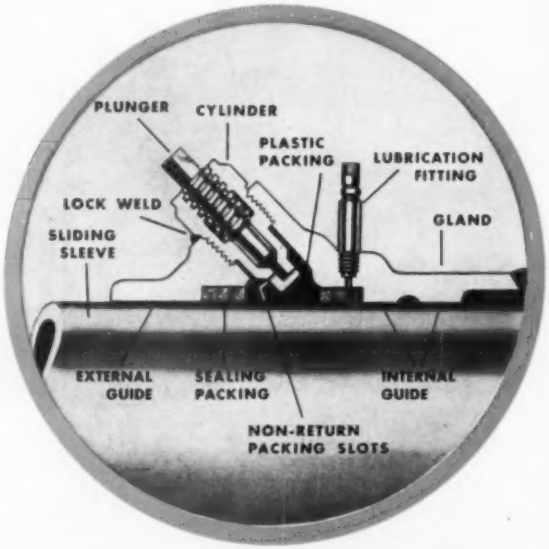


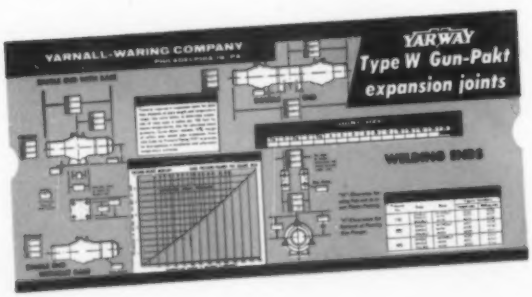
With Yarway GUN-PAKT Expansion Joints it is *never* necessary to shut down the lines to add packing to the joints. When additional packing is needed it is added *with the pipe line under full pressure.* A slug of plastic packing is inserted in the convenient screw-plunger gun—a turn of a wrench and the job is done, the joint is tight. Steam service is continuous. Costly shutdowns are eliminated. Joints never need repacking.

Yarway GUN-PAKT Expansion Joints give users these *extra* advantages, too:

- **Rugged dependability**—All-steel construction. Durable chromium plated seamless steel sleeves. *No chance of metal fatigue.* Wrought steel bases for positive anchorage.
- **Internal and external guides**—provide positive alignment in the stuffing box—*where it counts.*
- **Light weight, streamlined design**—requires less space to install, less space to maintain, smaller manholes.

Accept no substitute! Insist on Yarway GUN-PAKT—the original "packed under pressure" expansion joint, backed by 20 years of experience and thousands of successful installations to its credit.

For full information, and "blue chip" list of industrial plants, universities, institutions and central plants using GUN-PAKT Joints, write to Yarway.



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Want a *new* time- and labor-saving Yarway Expansion Joint Calculator which quickly provides sizes, weights, dimensions, anchor loads, etc. for Yarway GUN-PAKT Joints? Just call your Yarway representative and ask for one—or write us on your company letterhead and we'll see that one is delivered.

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NEEDED— A REAL POWER CONFERENCE AND SHOW

SEVERAL recent events have proved quite conclusively that some drastic steps must be taken to forge all power field interests into one top-flight organization.

First, the Power Conference in Philadelphia, in September, showed the wisdom and practicability of uniting two groups of power engineers in a "meeting of the minds" on common problems. Members of ASME and AIEE held a most successful conference — one devoted exclusively to *truly power subjects.*

Then — but on the opposite side of the ledger — two events, held concurrently, demonstrated the urgent need for action in the field of *unification.* The annual ASME meeting, and the Power Show, both gave evidence of what is lacking in the power field.

For several years, the Power Show has been on the downgrade — and for one simple basic reason: Exhibitors haven't been reaching the people they *must* reach! It is a sad indictment of an industry which should be the biggest in the U.S. when there isn't a *single* exhibition where all interested parties can mutually profit by "buyers" and "sellers" getting together.

Most of the major technical societies have grown so large that there is no longer *one* conference where power engineers can fill their needs for knowledge of new technical and manufacturing developments in power equipment. There is no criticism of the societies for growing *big;* however, a regrouping of specialized engineers *in all societies* is long overdue.

Since there are many *power engineers* in ASME, AIEE, ASCE, AIChE, and many other technical societies, why shouldn't they all meet on common grounds — and have a really profitable Conference, and Exhibition — tailored for their requirements?

To bring this critical problem into focus *quickly* and *practically,* POWER ENGINEERING offers a proposal — for what we feel is a good solution. And a solution which should interest all engineers, manufacturers, consultants, educators, contractors and top executives in the power field.

Here is POWER ENGINEERING'S 10-point proposal:

(1) Canvass all technical societies, in addition to ASME and AIEE, which might conceivably have a group of power engineers in their memberships. This canvass should ascertain whether members are interested in a specialized, honest-to-goodness *power* conference, and will actively support it.

(2) Select an independent Public Relations firm — with an established background in the power field — to handle all details of Conference and Exhibition organization.

(3) Procure a liaison (and advisory) representative from these organizations: the Founder Societies, Edison Electric Institute, American Power Conference, N.A.P.E., Government power agencies, manufacturers, and all other groups interested in the power field.

(4) Arrange to provide a really first-class agenda for the Conference; one which will provide the greatest number of power engineers with *new* knowledge on subjects interesting to all. Also, provide recognized authorities in all fields as speakers.

(5) Obtain full support of all manufacturers in the power field — with the understanding that Conference and Exhibit will be a completely integrated affair.

(6) Hold the annual Conference and Show in a city where both hotel and exhibition facilities are adequate. Also, where Conference and Show can be held in the same building.

(7) Confine the activities of this Conference to *power engineering;* stay clear of all "social, fraternal, political and awards" angles. Concentrate on covering as much ground as possible — in the strictly practical mechanical and electrical power engineering field, leaving research and design factors to the various societies and their transactions.

(8) Include Conference subject material which will cover Generation, Transmission, Conversion and Utilization of power. (Also, the agenda should cover matters of interest to *power engineers* in all walks of life — utilities, industry, government, military, manufacturing, transportation, etc.)

(9) No single segment of the power field should dominate the management of this new Conference and Show.

(10) Power engineers who have made good progress in the field should select the Conference subjects. Only engineers experienced in conference management should act as "masters of ceremony" at Conference sessions. (In fact, professional conference managers might contribute a great deal to the efficient execution of the sessions.)

Conference sessions should all be conducted on a strictly professional basis; timed like a television production; and with no long-winded reading of complete papers which are to appear in print.

That's POWER ENGINEERING'S 10-point suggested program! It's not just our idea; it's a composite of ideas from dozens of leaders in the power field. It is simply incredible that the most dynamic business in the world doesn't have the "greatest show on earth" for the men who run this business.

We offer this suggested program to all power engineers and manufacturers — and sincerely ask their comments. Won't you please give us your opinions? Please address your replies to the Editor, POWER ENGINEERING, 308 E. James Street, Barrington, Illinois.

TVA BUYS 800-MW TURBOGENERATORS

CHIEF ENGINEER GEORGE P. PALO TELLS HOW CONTRACT FOR WORLD'S LARGEST UNIT HAS BEEN AWARDED

ON DECEMBER 23, 1960, the Tennessee Valley Authority awarded to the General Electric Co a contract for two 800-Mw, 3600/1800-rpm steam turbine-generators. These units are believed to be the largest ever ordered. The first unit is scheduled to operate in September 1964 at a location not yet determined. Plans for the second unit are not firm; the contract permits its cancellation up to March 1, 1962, with some modification in the first unit's price.

For several years the size, and rate of growth, of the TVA system has permitted it to plan for the purchase of the largest possible turbine-generators. It is still too early to determine accurately the economies of this policy, but progress to date indicates savings even greater than expected.

TVA's first large cross-compound unit was purchased from General Electric Co in the fall of 1957. Up to the time the bids on that unit were invited, TVA was not able to get assurance from the manufacturers that 500-Mw units *could be built;* so the invitation-to-bid requested quotations on either 350- or 500-Mw units. Satisfactory bids on the larger size were obtained, and the contract was awarded. That unit is now operating.

About a year later, TVA awarded its first foreign turbine-generator contract, a 500-Mw unit, to C. A. Parsons, Ltd, of England. On this invitation, which requested a 500-megawatt unit, one manufacturer offered a *600-megawatt* size.

Next, in the latter part of 1959, from response to an invitation giving bidders a very broad choice of sizes, TVA purchased (on the basis of price) a 500-Mw unit, from the Brown Boveri Company. And, on the basis of price and delivery, a 600-Mw unit, from General Electric Co. Later the capacity of this unit was rerated to 650 Mw, and a second identical unit (for which an option had been taken) was purchased.

These General Electric units are to be installed in the Paradise Steam Plant, now under construction in western Kentucky. To the bid-invitation from which these units were purchased, one company offered an 800-Mw unit, but the offer was not as attractive as those for the units purchased.

In the summer of 1960, TVA decided that its system required further expansion to meet estimated load requirements for the winter of 1964–1965. Discussions were held with all domestic and foreign turbine-generator manufacturers. TVA then decided that the 800-Mw size was suitable to most of the manufacturers and would provide the most economical addition to its system. Therefore the invitation-to-bid, on which the contract was just awarded, required an 800-Mw unit, rated at 2400 pounds, 1050/1000 F.

Response of Bidders

Two domestic (and three foreign) companies responded to the invitation-to-bid. Bid papers specified that efficiency would be evaluated by adding to all bids an allowance of $18,-500, for each Btu per kwh that the guaranteed heat-rate exceeded the lowest heat-rate quoted. In addition, *all foreign bids would be charged an additional 40 per cent over the evaluated bid price, to cover features of the Buy-American Act,* and other costs and disadvantages involved in foreign purchase.

Although the lowest bid prices were received from foreign bidders, the two domestic bidders, General Electric and Westinghouse, offered considerably lower heat-rates. General Electric submitted the lowest evaluated bid and would have underbid the most satisfactory foreign bid if only half of the 20 per cent foreign differential had been added to the lowest foreign bid.

General Electric Co's bid offered several alternatives. Of greatest interest is the opportunity for TVA to choose, at any time before March 1, 1961, an 1800/1800-rpm unit, which will provide a better heat-rate but at a higher cost, or a supercritical-pressure unit for 3500 psi and 3600/1800 rpm. The latter of these alternatives is of particular interest.

We first gave serious thought to the possibility of supercritical units in 1957. Analysis indicated a very appreciable economy in favor of 2400-psi equipment; then, we reviewed this subject just prior to the recent bid-invitation. The margin favoring 2400 psi, over the supercritical pressure, had narrowed appreciably.

With the very satisfactory General Electric bid for the turbine-generators, TVA now finds it possible to make a very close check on the desirability of supercritical units by taking alternative bids for the *boilers* to be used with the units just purchased. Accordingly, TVA opened alternative bids on January 17, 1961, for boilers to supply steam for either 244- or 3500-psi turbine-generators. In the latter case, the steam conditions would be either 1000/1000 or 1000/1050. Discussions with boiler and turbine manufacturers resulted in dropping from consideration any other combination of single-reheat temperatures, or of double-reheat.

TVA's invitation for these new large units was timed so as to permit domestic manufacturers freedom in the planning of their fabricating schedules, or to give foreign manufacturers sufficient time on their slower schedules to meet TVA's operating dates. Both of the domestic bidders availed themselves of this opportunity. General Electric Co proposed, as an alternative (at a saving to TVA), the manufacture of the units as much as one year ahead of the schedule for which they will be needed at the plant site.

TVA accepted this alternative, considering it an important example of the possible benefits of coöperation between manufacturer and purchaser in ironing out the irregular workload in manufacturers' shops, resulting from the usual cyclic pattern of turbine-generator purchases.

Response, of both domestic and foreign bidders, to this invitation-to-bid has been exciting. The very fine proposals submitted both by General Electric and Westinghouse have provided solid evidence that domestic manufacturers of large electrical equipment are ready to make full use of opportunities to build bigger and better machines, on advantageous schedules, and that they can compete effectively with foreign manufacturers of such equipment.

Editor's Note — Total price of the two units is $30,400,000. THE END

THE STORY OF COAL FROM MINE TO BOILER

COAL is the power industry's basic fuel, providing about one-fourth of the energy used in this country today. It is estimated that coal accounts for more than two-thirds of the kwh generated from fuels in the U. S. In another 15 years, the experts say, the coal industry's present annual production of over 430 million tons will soar to 750 million tons to meet the nation's expanding needs.

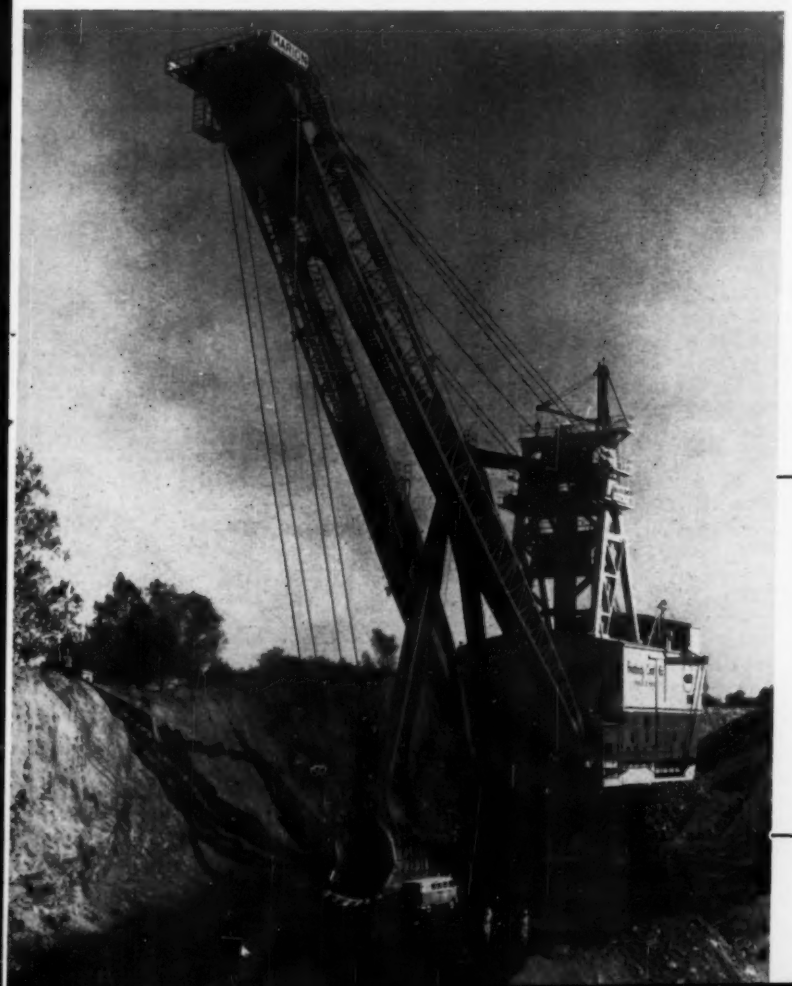
The story of how this precious material is mined, prepared, transported, stored and handled at the receiving end makes fascinating reading, especially for the power engineer. For not only is coal the lifeblood of his industry, but the coal story today is in itself an adventure in power engineering.

It's really the ingenious power systems, machines and devices that man has perfected for coal production and handling, that have established coal so indisputably as the prime fuel.

Since cost of fuel is the largest single increment in the cost of energy generated by utilities, coal companies have constantly improved their methods to keep the cost of coal at a minimum. Years ago, mechanization began to replace the old-fashioned methods of hand mining and small car movement. And in later years, complete automation has supplemented the mechanization of previous years. All of this has contributed to the maintenance of low-cost coal which is reflected in the cost of electricity to the users.

In developing this story, we sought out a large coal company that has all of the latest techniques and equipment which would be of most interest to the power engineer — The Peabody Coal Co, with headquarters in St. Louis, Missouri. Then, as a typical using plant, we are drawing on the experience and resources of the Detroit Edison Co.

Stripping shovel used at Peabody Coal Co's Lynnville mine in Indiana is one of the largest, takes 65 to 70 cubic yards of earth and rock at each bite



Here, then, is an up-to-the-minute picture of power at work on coal in

underground mining
strip mining
hauling and unloading
storage
final handling

Watch this picture unfold as issues of POWER ENGINEERING go by over the next few months. It's your record of what goes into the engineering for a modern coal system, from mine to boiler.

POWER SERVICES FOR THE LARGEST U.S. UNDERGROUND COAL MINE

PEABODY COAL CO'S MINE NO. 10 NEAR SPRINGFIELD, ILL., IS PRODUCING ABOUT 400,000 TONS A YEAR. H. C. McCOLLUM, VICE-PRESIDENT, HERE DESCRIBES HOW THE JOB IS DONE

MINE NO. 10 is in Christian County, Ill., on State Route 104, about four miles east of Pawnee. It is served by the Chicago and Illinois Midland Railroad. The mine, which went into operation in 1952, was originally planned to mine and prepare 13,600 tons of clean coal daily. It is now producing an average daily tonnage of 20,000 — approximately 400,000 tons per year, estimating 200 working days, on two coal-producing shifts.

Peabody Coal Co had operated mines in the Central Illinois area for a good many years. It was decided to make Mine No. 10 one of the model mines in the country and, after due consideration of the latest developments in 1950, it was decided to open a slope mine and to use belts instead of mine cars for the haulage of coal.

At the time the mine was opened, continuous mining machines had not been developed to a point of economical operation. Therefore, the original purchase — new in its day — is today considered the conventional mining equipment, consisting of rubber-tired mounted cutting machines, rubber-tired mounted coal drills, caterpillar-mounted loading machines, and four-wheel drive and steer shuttle cars.

Sequence of operation is as follows: 1. coal is undercut to a depth of 9 feet, 2. coal is drilled, 3. shot with compressed air, and 4. loaded by caterpillar-mounted loader equipment into shuttle cars.

The coal is then discharged by means of a chain conveyor in the bottom of the shuttle car onto a belt whence it is carried continuously on belts to the preparation plant on the surface. It is then prepared, sized, and loaded into railroad cars.

After the continuous mining machine was perfected, two of these units were purchased and are in operation at Mine No. 10. The continuous miner is used on development work and does not require any cutting, drilling, and shooting operations.

The slope, or entrance, to the coal reserves is in the center of a rectangular field five miles wide and ten miles long which will yield 100,000,000 tons of clean coal.

Slope Operation

The mine is a slope operation, 16-degree slope, 1270 feet long, into bituminous Illinois No. 6 seam, which averages 86 inches in thickness. Depth from surface to coal is about 350 feet.

The electric power demand at the mine varies between 6000 to 6200 kw. Main transformer station at this mine is company owned and consists of three transformer banks with a capacity of 6000 kva, 12 oil circuit breakers, bus structures and necessary switching equipment.

Electric power is purchased from Central Illinois Public Service Co and metered at Peabody's main transformer station located centrally to such buildings as preparation plant, slope hoist, shop and supply, office and wash-house, Airdox and ventilating fan. Incoming power is reduced from 34.5 kv to 2400 volts in two 1500-kva transformer banks connected delta-delta for above-surface operations.

Surface operations are fed from electrically-operated oil circuit breakers (with controls on the engineer's console) and through an underground duct system. Each circuit breaker is rated at 600 amp, 14.4 kv, with an interrupting rating of 100,000 kva, and is equipped with trip-free operating mechanism, capacitor trip, overcurrent relays with instantaneous trip attachment, indicating lights, ammeters, switches, etc. A tie breaker permits the paralleling of both transformer banks if that should become necessary, and switching is such that if either bank failed, the most vital circuits can be connected to the bank still in service. A 3000-kva transformer bank connected delta-wye with solid ground connected in the secondary neutral circuit reduces the incoming power from 34.5 kv to 12,470 volts. The underground operation is fed from this transformer bank through an electrically-operated oil circuit breaker and a 12,470-v overhead transmission line to substations located at boreholes.

At each borehole location 12,470 volts is again reduced to 4160 volts in 450- and 1500-kva transformer banks connected delta-wye to a ground resistor connected in the secondary neutral circuit. The neutral ground resistors are rated 48 ohm, 50 amp and 10.85 ohm, 200 amp. A 5-kv, 600-amp, manually-operated oil circuit breaker with an ammeter shunt trip, overcurrent and ground trip relays, is enclosed in a wood switchhouse in each outlying substation to protect the borehole cable against short circuits and overload.

Three-conductor, sizes No. 2 and 350,000 circular mil, stranded, 5000-v mine power cable, shielded and ground wires, neoprene jacket, are

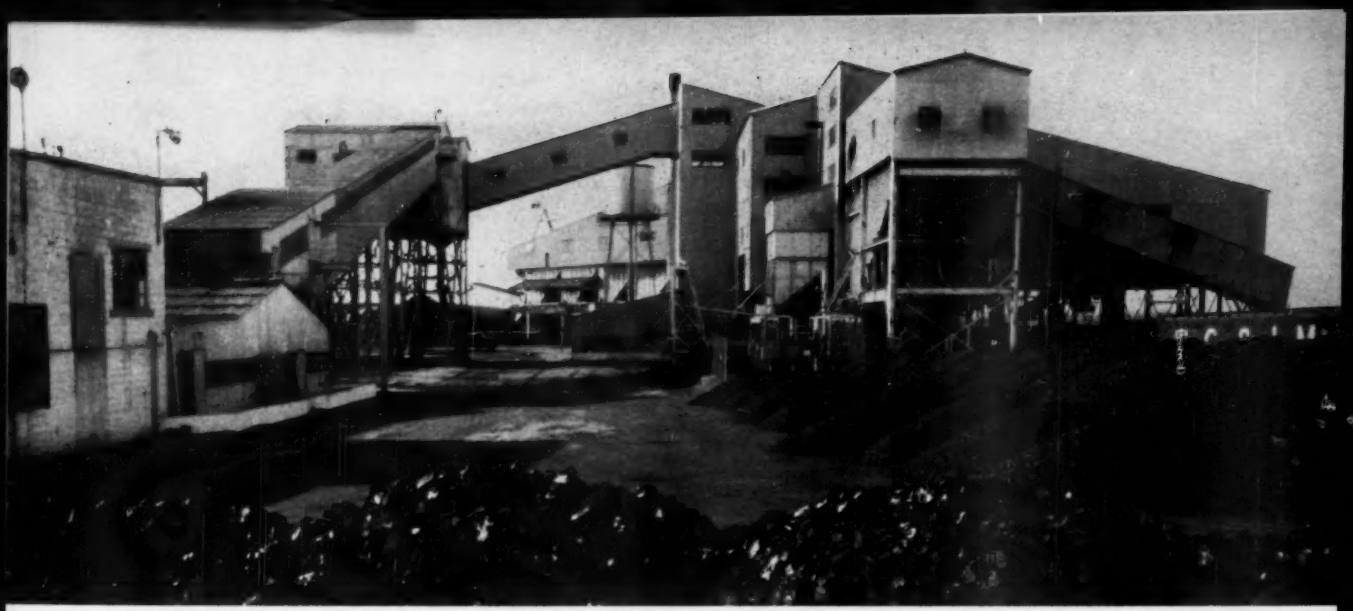


Fig. 1. View of washing and preparation plant, Peabody Coal Co's Mine No. 10. Mine operations require from 6000–6200 kw

used for borehole cables. These cables are suspended at top of the borehole pipe with wood clamps backed by steel plates.

Switch-rooms are located underground, at or near the boreholes, for East and West sub-mains off the main entry. These switch-rooms house the disconnect switches, main and distribution oil circuit breakers, manually operated for 4160-v feeders. One thousand-foot lengths of mine power feeder cables, stranded, size 4/0 of the 5-kv class, with ground wires, are installed on insulators and connected to junction boxes and load-break switches along the sub-main entries.

Electric power at 275 volts dc for mining equipment in the panel entries and rooms is furnished by 300-kw synchronous motor generator sets, with across-the-line type and automatic a-c and d-c panels. Three motor generator sets furnish power for four units, each unit consisting of the following mining equipment:

3—shuttle cars—each with wo 6-hp and three 10-hp motors.
2—11 BU loaders—each with one 4-hp and one 50-hp motor.
2—coal drills—each with three 4-hp motors.
2—roof bolt drills—each with three 4-hp motors.
1—10 RU cutter—each with one 28-hp and one 75-hp motor.
1—timber truck—with a 4-hp and 10-hp motor.
1—36-in.-wide belt conveyor—average length 1500 ft with a 50-hp motor.

Three 300-kw motor generator sets with 450-hp synchronous motors and three 42-in.-wide belt conveyors, each 4200 feet long and with 150-hp wound rotor motors, all 4160 volts, are fed by one 1500-kva transformer bank.

Two 300-kw motor generator sets with 450-hp synchronous motors fed by a 1500-kva transformer bank furnish power for miner and conventional unit consisting of the following equipment:

1—miner with two 100-hp, one 20-hp and two 10-hp motors.
1—11 BU loader with a 4- and 50-hp motor.
1—coal drill with three 4-hp motors.
1—roof bolt drill with three 4-hp motors.
1—10 RU cutter with a 28- and 75-hp motor.
1—timber truck with a 4- and 10-hp motor.

The mining of coal is carried out on the panel, room and pillar system.

Fire extinguishers and supplies of rock dust are kept at belt drives, motor generator sets, oil stations and other strategic places underground.

All men underground use permissible electric cap lamps for portable illumination.

Conventional trackless mining with undercutting machines, coal and roof drills, air breakage of the coal faces, loaders and shuttle cars produce coal for delivery to a belt haulage system. Roof support by bolting, with prop-and-bar timbering where necessary, is standard practice. Auxiliary conveyance of supplies is provided by battery-powered shuttle cars.

Conveyor Belts

Panel conveyor belts 36 in. wide and approximately 1500 ft long, and driven by a 50-hp d-c motor, convey the coal to three 42-in. sub-main conveyor belts, each 4500 ft in length, operating in tandem. Each conveyor is driven by a 150-hp, 4160-v a-c motor and control equipment for starting and accelerating the wound rotor motors.

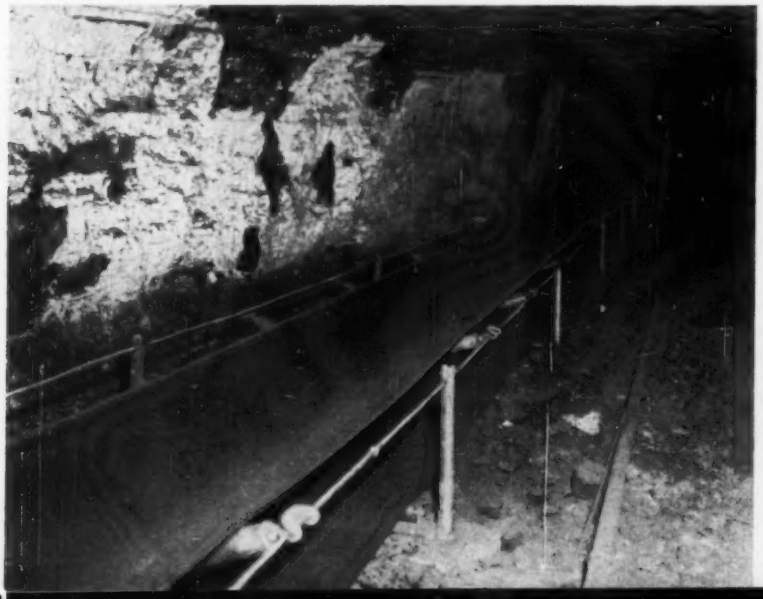


Fig. 2. Revolutionary underground haulage system invented and patented by technicians at Mine No. 10. Wire rope-supported rollers provide shock absorber action, reducing belt wear and eliminating steel structure and supports

Fig. 3. One of two continuous mining machines in use at Mine No. 10 eliminates undercutting, drilling and shooting

These conveyor belts discharge onto a 48-in. wide transfer belt at the intersection on the main entry. The transfer belt discharges onto three 48-in.-wide main entry conveyor belts approximately 4000 ft long operating in tandem, and one 48-in.-wide mother belt conveyor 800 ft long, and from thence to a short shuttle belt conveyor which distributes the coal into a 1300-ton storage bin.

Each main entry belt conveyor is driven by two 150-hp, 4160-v a-c motors, and control equipment consists of one unit for starting and accelerating two wound rotor motors. Control equipment for the mother belt conveyor is a duplicate of that used by the sub-main conveyors except that it is operated on 2400 volts.

Two syntron feeder units near the slope bottom remove the coal from the storage bin onto a short accelerating belt 48 in. wide and discharges it onto the 48-in. slope belt which conveys the coal up the slope to the preparation plant on the surface.

Slope belt conveyor is 48 in. wide, approximately 1700 ft long, and is driven by three 250-hp, 2300-v, a-c wound rotor motors which are connected by V-belt drives to speed-reducing gears in turn directly connected to main drive pulleys, which includes two Wonway automatic backstops.

System for starting and accelerating the wound rotor motors includes a single air break line contactor to energize the motor primaries simultaneously, timer, three secondary compartments with contactors and other necessary control. A number of protective and signal devices terminating in the engineer's console and arranged to shut down the drive are provided at various points along the belt. The slope belt conveyor originally rated 1000 tons per hour actually carries over 1300 tons per hour with a 476-ft vertical lift and operates at 470 fpm.

When coal enters the preparation plant it is washed, screened, and sorted into various sizes and loaded into railroad cars and trucks for shipment to different parts of the country. Amount of coal washed is about 50 per cent of the total output of the mine. A 1050-kva transformer substation, rated 2400 to 480 volts, furnishes electric power for this plant.

A 6-ft fan of propeller design, blowing, installed on the surface and capable of delivering over 200,000 cfm, provides ventilation to the mine underground. Drive for this fan consists of a V-belt drive and jackshaft assembly with clutches mounted between a 400-hp, 2300-v, full voltage start a-c induction motor and a standby gasoline engine rated 110 bhp. Starting equipment includes a set of disconnect switches, reverse switch and magnetic starter for the motor. Automatic controls are provided to start and stop the gasoline engine automatically in case of a-c power failure, plus other safety devices such as bearing temperature relays, visual and audible fan signal.

Slope Hoist

The electric slope hoist is manually operated in lowering and raising men and material into mine and is direct-connected by a reduction gear and coupling to a 250-hp, 2300-v, a-c wound rotor motor. A 100-hp, 440-v wound rotor motor is used for auxiliary drive and is direct-connected to a coupling gear reducer airflex clutch and pinion to the main drum shaft gear for lowering and raising heavy machinery into the mine. Both motors are operated by drum controllers, primary and secondary contactors. Safety devices such as a Lilly controller and tachometer indicating speed of the hoist are a part of the control for these units.

A dolly car with electric brakes is used for lowering and raising man-trip cars and material cars into the mine. A man-trip consists of a dolly car with a seating space for four men, and two man-trip cars, each of which can handle 36 men standing, or a total of 76 men can be lowered into the mine per trip.

Men are transported from the slope bottom to the working sections in specially constructed all-steel man-trip cars drawn by an electric locomotive.

Communication equipment consists of conventional magneto telephones installed at a fixed point and trolley-phones installed on electric locomotives. This system provides instant and continuous contact not only from equipped locomotives to the dispatcher, but between locomotives whether standing or moving.

Compressed Air

The Airdox compressor installation (compressed air used for breakage of coal at the face) is located on the surface and consists of 15 compressor units each driven by a 50-hp, a-c induction motor. Control is completely automatic, which is made possible by use of low- and high-pressure switches and timer for starting three units simultaneously followed by three more, or until all 15 units are on the line. This installation is fed by a 750-kva transformer bank, rated 2400 to 480 volts.

All major repair to mining equipment is brought to the surface and taken to a well-equipped and well-lighted shop where it can be dismantled if necessary and completely rebuilt for future use.

Sodium lamps provide adequate light along the empty and load tracks and make it possible for car riders and railroad men to see switches, judge speed of oncoming cars, and will allow employees to walk on or between cars safely. The control for this lighting is automatic in that the lights are turned on and off by a time switch which can be set to operate at sunrise-sunset. Two 25-kva transformers with a voltage rating of 2400 to 120/240 volts, single phase, furnish power for track lighting. THE END

LARGE-SCALE FUEL ECONOMY PROMISED WITH DISTRICT HEATING—2

GEORGE RETI, PROJECT ENGINEER, THE KULJIAN CORP, DESCRIBES

THE MANY BENEFITS OF BACK-PRESSURE POWER GENERATION

BASIC SYSTEMS for district heating, together with the thermodynamic background, were described in the Nov 1960 issue of POWER ENGINEERING, p. 72. Now we will look at some actual applications and consider the major benefits to be derived from central heating.

Many existing steam power plants possess small outmoded turbine generators which serve no useful purpose. These old units can sometimes be used very successfully in back-pressure service to produce by-product power while supplying a heating load.

Changing the purpose of our turbine generator may cause pressure and temperature conditions within the machine to depart rather widely from original design conditions (see POWER ENGINEERING, March 1960, page 67, "Changing Steam Conditions?"). In particular, exhaust temperatures may be much higher. If the shaft bearing on the low-pressure end is built into the exhaust hood, as was common practice when many of these older units were manufactured, that bearing may overheat and cause trouble. In such a case some method of cooling the bearing must be worked out before the unit can be put into service.

Building the System

It may be possible to employ the original condenser as the heat exchanger for producing hot water, provided the pressure and temperature limits of the condenser are not exceeded. Obviously, only a part of the water heating can be done in a condenser which cannot withstand the steam pressure required for full heating. In such cases the water leaving the ex-condenser can be brought to final temperature in an exchanger fed with higher pressure steam extracted from the turbine or drawn direct from the mains. This would not be an extra exchanger but merely an enlarged version of the unit customarily provided to take care of peak heating demand.

Existing cooling water pumps will ordinarily be high-capacity units unable to develop sufficient head for a hot water circulating system. In most cases the water side of the condenser will be unable to stand the pressure required for circulation. It will then be necessary to develop full-line pressure by means of a pump located on the discharge side of the condenser, while a booster pump ahead of the condenser maintains sufficient pressure to prevent flashing of the heated water. This system is indicated in a simplified single line diagram, Fig. 1. The expansion tank safeguards against overpressure in the condenser.

To obtain manageable circulating water quantities in large heating systems, we usually cannot insist on utilizing the steam to the utmost low pressure for power generation. To increase heat concentration in the transport medium we have to in-

Fig. 1. Simple system employs outmoded turbo-generator

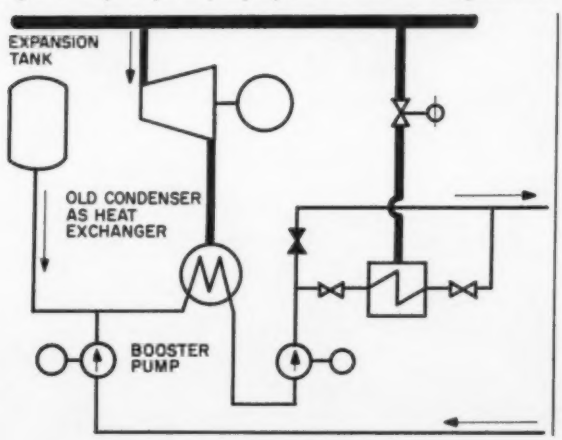
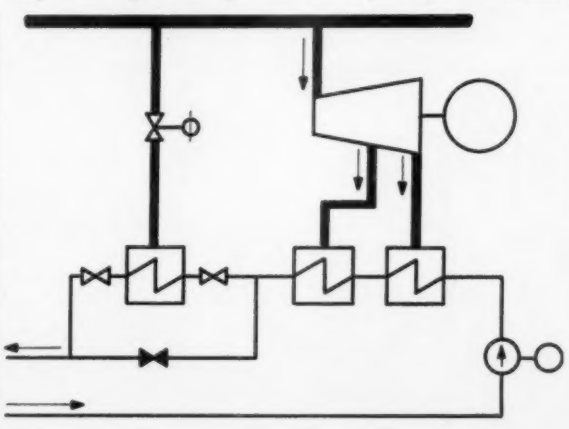


Fig. 2. Stage heating makes the system more effective



crease its temperature, which means higher back-pressure for the turbine. But the reduction in power generation can be minimized by splitting the temperature rise into two (or more) steps, similar to boiler feedwater heating in a conventional power plant. Such a system is indicated in the simplified flow diagram of Fig. 2.

Stage Heating

The turbine has an uncontrolled large extraction opening, sized to extract half of the expanding steam; the last stages are also designed for only half of the throttle flow. This equal load distribution is undisturbed only at or about the design load. At loads differing from the design conditions a significant shift can occur in the steam load of the two heaters.

Nevertheless, stage-heating is superior to the single heat-exchange system. In the two-stage system, net gain approximates the power generated by the amount of steam expanding from extraction pressure to back-pressure, utilizing the enthalpy difference between the two points.

Such a special turbine, feeding an extensive heating system, has been operating efficiently in Hungary for five years.

The same idea can be utilized when a power plant has several small-capacity condensing units, outgrown and out of service, or when an extremely large heating circuit has to be supplied by one plant.

This stepwise heating is shown in Fig. 3. Such a system is very flexible concerning load changes and maintains high efficiencies at extreme load conditions, shutting down or starting units according to requirements. A system applying this principle has been built recently in Sweden and was described in the April 1960 issue of POWER ENGINEERING, p. 80.

Although we do not know whether it has actually been carried out, the bold proposal put forward in 1951 by V. B. Paksvev in a Russian magazine is worth mentioning. The idea is to combine heat, water and electrical supply for a city located far away, say 60–70 miles from the power plant. See Fig. 4.

There is no recirculation. The heat transfer medium, after releasing heat for domestic heating, is used for hot water (and cooled for domestic water) supply. The idea is worth consideration where large industrial plants and communities have to be located in arid and cold mountainous areas. It shows how extreme conditions can make remote heating competitive even for unusually long distances.

According to the original proposal, the unit (a 50,000-kw turbine generator) would work in condensing operation, discarding a part of the cooling water. The remaining part of the cooling water would go through the heat exchanger system and leave the plant at high (360 F) temperature. By adjusting the heating water amount and temperature, and the quantity of discarded cooling water, a wide range of heat, water, and power demand could be supplied efficiently.

Economy

In evaluating different competitive solutions we have to establish the system with the lowest yearly cost, including depreciation, cost of investment capital and cost of operation.

For central (or remote) heating systems, the most promising conditions are found when entirely new communities are planned. Here the immediate savings in individual heating units and accessories offer a sizable compensation for the cost of the distributing system. Savings will show up not only in eliminating the individual heating units proper, but in reduced cost of fuel storage, oil piping, etc.

If the savings mentioned will not pay for additional cost of the hot water distribution system, remote heating can still be made attractive by taking into account the savings achieved in fuel cost by generating by-product electric power. These savings are made up of the following items: Less expensive fuel can be burned in the power plant; combustion is more efficient than in household heating units; and part of the fuel cost can be charged against power generation.

On the other hand, in making fuel cost calculations, unavoidable heat losses of the distributing system should not be left unaccounted for.

To supply existing communities might also be feasible, especially where the winter is long and severe, the fuel cost high, or the population density is high enough (urban areas) to hold the specific cost of the distribution system down.

Remote Air Conditioning

Since central or remote heating is technically and economically superior to individual home heating, it is logical to take the further step of examining the feasibility of central air conditioning.

Before discussing thermodynamics and technical solutions, let us first investigate the economic aspects. The most attractive feature is that the water distribution system needed for remote heating can be used without modification for distributing chilled water in the warm season. Cost of the most expensive item, the distributing piping system, can be split between the two services, thus increasing significantly the feasibility of both.

In considering applicable cooling cycles, we certainly shall prefer the ones utilizing low-pressure steam as energy source. Most promising seems to be the steam ejector-vacuum system which requires only 4–6 psig for

Fig. 3. Flexible stepwise heating with multiunit plant

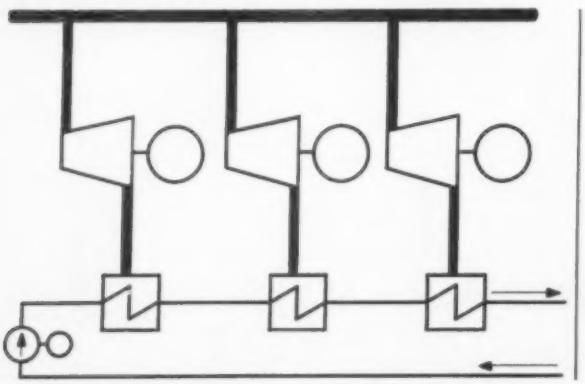
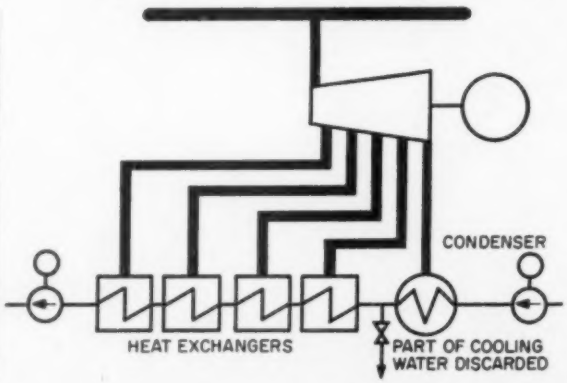
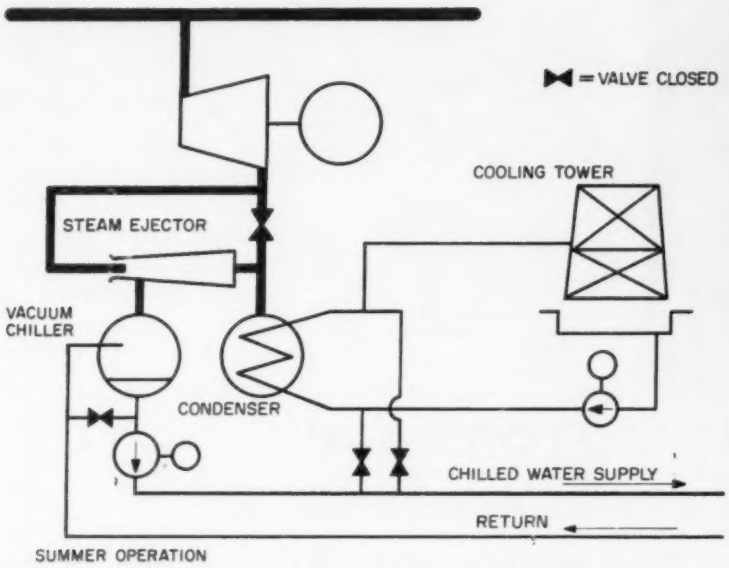
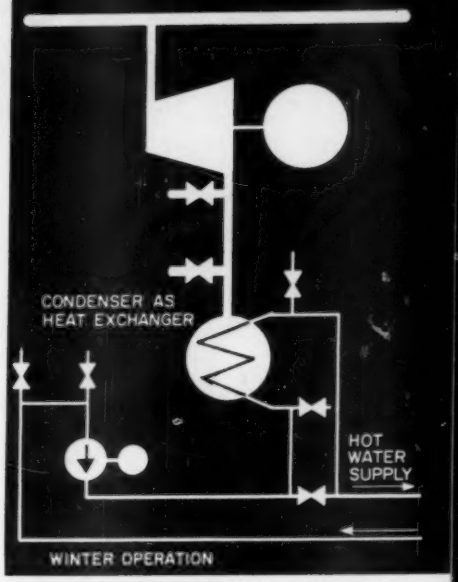


Fig. 4. Proposed Russian scheme for distant service







Figs. 5 and 6. For maximum economy provide central air conditioning during summer months and heat during the winter months

the ejectors. Fig. 5 shows the simplified diagram of such a unit. A special attraction of this system is the double purpose utilization of the condenser which works as a heat exchanger in winter and as a condenser in summer. Just a small additional amount of inexpensive equipment has to be installed to provide the water chilling service along with the heating.

Multipurpose Plants

In winter, turbine exhaust steam enters the condenser-heat exchanger directly. The circulating pump forces the returning heating water through the condenser and then into the distributing system.

In summer, the direct flow of the steam into the condenser is interrupted (by butterfly valve, or simple blind flange), and the turbine discharge steam passes through the ejectors before entering the condenser. Chilled water returns enter the evaporator-chiller, and the circulating pump discharges directly into the distributing system. A cooling tower or fresh water cooling cycle is attached to the tube side of the condenser.

Another low-pressure steam user is the absorption cooling system. Higher back-pressure is required, 8–10 psig for a lithium bromide system, and the initial cost is also somewhat higher than for the ejector-vacuum system described above.

In addition we should not reject without study the conventional compression refrigeration system. That system also offers economical combinations of equipment such as driving large Freon compressors by steam turbines. These again could be the small out-of-service steam turbines.

The exciter has to be removed and the compressor coupled directly to the generator shaft, because usually the exciter shaft is not strong enough to transmit the torque for the compressor. The generator can be operated as a separately excited unit with its old exciter motor driven.

This last solution does not provide by-product electric power in the same sense as do the previous set-ups. But, in the air conditioning season, a condensing power generating capacity is available, the size of which is inversely proportional to the refrigeration load.

Beside the three major services, namely electric power generation, hot water heat and chilled water air conditioning, one further service which might be considered is domestic hot water supply. With proper choice of temperature, such a service could share the distribution system designed for hot water heating. However, since domestic hot water needs continue throughout the summer it would be necessary to provide a separate system for this supply if chilled water distribution for air conditioning were contemplated.

Consideration Beyond Economy

After carefully considering the economic aspects in any particular case, we should spend no less care in some aspects which cannot be fully evaluated on an economic basis. It might be useful to mention some of them.

Above and beyond fuel economy it is in our national interest to conserve the more rapidly diminishing petroleum-based fuels as against the more abundant coals. For power plant purposes, even the lower grade coals are adequate.

Incomplete combustion in thousands of individual heating units can be blamed, at least in part, for the air pollution in our communities. Every step taken to ease the air pollution will benefit all of us. Beyond doubt the central power plant, applying modern measures for smoke control and dust precipitation, can burn high-ash fuels without polluting the atmosphere significantly. Beside that, the power plant can and should be located at a safe distance from residential areas.

It may seem that central heat supply results in some curtailment of the individual's choice of home heating conditions, by controlling centrally the heating temperature. But when an adequate control range is left for the individual homes, this feeling will not arise.

The Future

It goes without saying that all the schemes discussed above can be applied in conjunction with atomic steam generation (see POWER ENGINEERING, Aug 1960, p. 56, ATOMICS). Regarding the more severe temperature limitations in the atomic plant, the back-pressure operation is especially advantageous in this respect.

It may be no exaggeration to envision in the not too distant future, atomic power plants supplying power, hot water for heating and domestic use, and chilled water in summer for air conditioning for the surrounding communities. THE END

WHEN MOTORS FAIL

WHAT'S THE RIGHT WAY TO PROCEED BOTH WITH THE REPAIR PROBLEM AND FAILURE ANALYSIS? R. L. NAILEN OF WESTINGHOUSE GIVES HIS EXPERIENCE

ELECTRIC MOTORS that keep the average industrial plant in operation are rugged pieces of machinery. But in spite of sound design and construction, and the best of maintenance programs, they do sometimes break down.

When failures do occur, a number of precautions should be taken to insure that the drive gets back in service with a minimum of time and cost. Equally important, proper diagnosis of the failure will reduce the chance of similar trouble in the future.

To begin with, if continuity of service is important in your plant, plan for failures. This doesn't mean you should not have faith in your motors. It means that you should make a careful economic analysis of what motor failure will cost you in terms of down time, and then determine what you can afford to keep on hand in the way of spare parts and complete spare motors. Ask the motor manufacturer for spare parts recommendations, and apply your own repair experience as well.

When a motor breaks down, find out how it failed. If anyone was present, find out from him just what happened. Did the motor suddenly stall? Make unusual noises? Smoke, or throw sparks? Did anything appear to go wrong with the rest of the drive — coupling, belts, or load? Operating conditions at the time of failure often furnish a clue to the cause of trouble.

Troubles in the drive itself that can cause motor failure are well known: misalignment, excessive belt tension, pump vibration, too much bearing thrust load, torque demand too high. However, when troubleshooting, don't overlook the possibility of electrical troubles in your power system as well. System voltage shouldn't sag more than 10 per cent (except momentarily) with all system loads at maximum value. This is especially important when you use 220-v motors on 208-v systems; then, voltage dip shouldn't exceed 5 per cent. Reduced voltage means high current, and consequent overheating.

Another system problem that has been overlooked is the necessity for proper grounding of apparatus and of the system. A danger here is the intermittent arcing ground of the "repetitive restrike" type. Occurring on a remote and unsuspected piece of equipment, such a failure can boost ungrounded system voltages to dangerous levels. In one example, a line-to-ground voltage of over 1200 volts appeared on a 480-v system. Scores of motor windings failed around the plant during the hours it took to locate the trouble!

Be sure the motor control is functioning properly, and that fuses or overloads in the motor starter are the right size.

Be sure three-phase voltages are balanced. Voltage in one phase only 5 per cent lower than in the other two phases may produce 20 per cent higher than normal current in part of the winding.

How to Disassemble

First step in repairing the motor is: *disassemble it properly.* (This assumes you're equipped to do most repair jobs in the plant; perhaps only a rewind or major overhaul needs to be sent out.) This means two things: use proper disassembly methods to avoid damage to reusable parts; and secondly, as the parts are taken down, check them over carefully for evidences of trouble. Points to watch in the first category are:

1. Remove ball or roller bearings from shafts only by pressing against the *inner* race of the bearing. The force required to get the bearing off, if applied against the outer race, can ruin the bearing.

2. Unless you have facilities for dynamic balancing of rotor-shaft assemblies after repair, match mark blowers and other rotating parts for proper reassembly in the same relative positions as they were in originally. This is especially important for 3600-rpm motors.

3. In small motors (usually below 50 hp) in which the rotor is shrunk on the shaft rather than being pressed and keyed, it is seldom feasible to press out a damaged shaft and press in a replacement. The shaft should either be cut off and drilled out, or the entire rotor-shaft assembly should be replaced as a unit.

4. Don't throw any parts away. In the first place, if a proper replacement turns out to be unavailable, the old part may have to be used as a model to improvise a new one. Secondly, valuable evidence of the cause of trouble may be lost if any part is prematurely discarded.

5. To avoid casting damage, don't use sharp tools, such as chisels, for removal of end brackets.

6. Before trying to remove parts from the assembly, make sure they're free to come off. Watch for internal bearing caps which must be unbolted before removal of the bearing from

its housing. Watch for snap rings used to retain bearings or shafts.

7. Avoid dragging the rotor against the stator winding when removing (or replacing) the rotor-shaft assembly. Rotor windings on wound-rotor motors are easily damaged this way, too.

Symptoms to Watch For

As the parts are disassembled, look for these symptoms:

1. Grease or oil on the windings. (Cause: defective seals or bearing; over-lubrication; improper lubricant.)
2. Blued surface of rotor, indicating overheating in rotor. (Cause: defective die casting in small aluminum rotors; cracked rotor bars in brazed rotor designs; a duty cycle that is too hard on the rotor, such as too frequent starting or reversing, or excessive load inertia.) See Fig. 2.
3. Bright streaks or wipe marks around the periphery of the stator or rotor, indicating rubbing. (Cause: loose bearings; bent shaft; distortion of frame; bits of lamination broken loose from rotor and caught between rotor and stator.)
4. Broken rotor tooth laminations.
5. Rusty bearings. (Cause: water leaks in plant equipment; failure of seals; improper lubrication.)
6. Dry bearings.
7. Any fretting, rub marks, or cracked welds indicating movement of parts—such as rotor creeping on shaft, stator loose in frame, etc.
8. Discolored bearings (ball or roller), indicating overheating. (Cause: excessive radial or thrust load on bearings, or failure of lubrication.)
9. Dirt in bearings.
10. Pitted bearings as result of failure of bearing insulation (where used) allowing flow of shaft currents. Some large motors require this insulation because of voltages generated in the motor shaft; this is a peculiarity inherent in the magnetic design of the motor.
11. Rough or worn surfaces of slip rings or commutators.
12. Cracked or pitted brushes, or brushes sticking in their holders.
13. Broken brush holder springs.
14. Loose or broken lashings holding cross connections, leads, and coil supporting parts to windings.
15. Signs of rubbing, with resulting deterioration of insulation on leads where they may pass against metal parts of the stator, rotor, or frame.
16. Oil or grease seals (felt, neoprene or leather) "beaten out," glazed and hardened, cracked, etc. (Cause: dirt; bearings overheating; excessive shaft whip due to loose bearings or bent shaft; rough shaft.) Look for worn shaft fits where seals ride on shaft, too.
17. Missing bolts or lockwashers.
18. Worn oil rings. This may cause failure of lubrication in sleeve bearing motors.
19. Rub marks in bearing housings indicating outer races of anti-friction bearings have been spinning.
20. Loose slot wedges, or damaged wedges, in windings.
21. Cracked or broken damper bars in rotor (see Fig. 1).

The foregoing list includes the visual checks only — things that can easily be seen. If any "mechanical" trouble is evident, from above conditions numbered 3, 7, 8, 18, or 19 particularly, there are some further checks that can be made using measurement methods available to the average shop. These are:

Clearance in bearings. Sleeve bearings should have a clearance over shaft journals of 0.002 inch to 0.003 inch per inch of journal diameter. Likewise, these bearings should not be too loose in their housings. Fit here ranges from a press fit on small bearings to several thousandths looseness for large spherical-seat bearings which must be free to rotate slightly in the housings to compensate for small angular misalignment. Ball bearings should be tight on the shaft by an interference of 0.001 inch to 0.002 inch, and loose in their housings by about twice this amount.

Straightness of shaft. Shaft bends producing only 0.005 inch to 0.010 inch runout (total indicator reading) at the pulley end of the shaft can cause noticeable vibration and noise in the drive, and premature bearing failure is likely.

Concentricity and squareness of fits between bearing and housing, end brackets and frame, etc. Bearing misalignment is produced by improper fits.

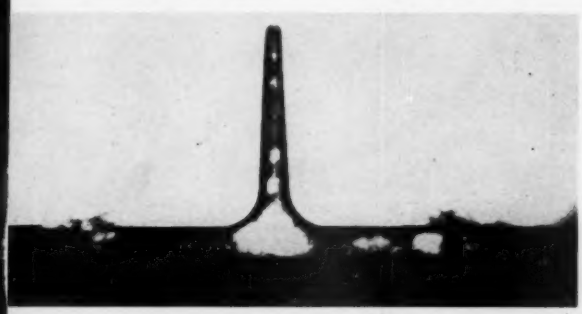
The average maintenance program, particularly involving large motors, will include checks for most of these defects at periodic intervals. However, when a failure has occurred, it shouldn't be taken for granted that the conditions checked at the last inspection are still existing. Go over the failed unit with at least as much care as the one that hasn't failed.

If you contact the motor manufacturer concerning the trouble, just for advice or to order parts or to arrange for him to do the repair at the factory, *give him all the facts.* Start with the *complete* nameplate data on the motor. In these days of stainless steel nameplates, the plate stays readable indefinitely. (Of course, one of the first things put down in good maintenance records is the nameplate data. If it can't be read later from the motor, it's available in the records.)

Tell him what the motor is driving;

Fig. 1. Rotor on 2000-hp, 3600-rpm motor showing broken damper bar at center that failed in fatigue after years of hard service. Look for this sort of thing when rotor sparks at startup

Fig. 2. X-ray picture of portion of end ring in die-cast aluminum rotor winding, 75-hp squirrel cage motor. Light areas show porosity in aluminum which overheated rotor. Projecting fin is the blower vane



what sort of duty cycle is involved; just what happened to the motor; what was found when it was taken apart. Try to use terminology that will leave no doubt as to what part of the motor you're talking about.

As soon as it's apparent what's going to be needed to make repairs, *order the right replacement parts.*

If proper renewal parts are not on hand, it is best to ask the motor manufacturer for *complete* identification (he will probably be able to supply a new bearing from his own stock at least as quickly as it could be obtained elsewhere).

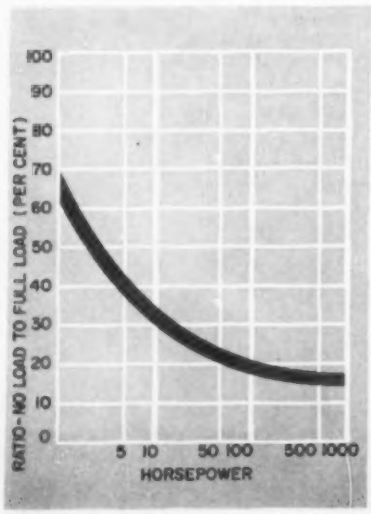
You want to avoid such things as replacing a prelubricated and sealed cartridge-type ball bearing with a regreasable one of the same basic size; replacing a heat-stabilized bearing for high ambient temperatures with one designed for normal temperature service; replacing an unshielded "open" bearing with one having shields that won't permit regreasing to reach the bearing.

Another serious problem: large motors (above 250 hp) commonly use ball bearings having larger internal clearances than standard. Bearing fit on the shaft is proportioned to take up a predetermined portion of this clearance by expansion of the inner bearing race as it is pressed on the shaft. Use of a conventional bearing of the same size results in excessive loss of clearance within the bearing; failure may occur after a few hours of operation.

Very old motors, of course, may require some improvisation.

When the expedient thing is to improvise a repair without exact replacement parts, here are some things to look for:

Fig. 3. Relation between no load and full load current for 1800-rpm motors



1. In repair welding motor frames or brackets, building up worn shafts with weld, etc, use great care to avoid distortion or machine fits. Check all fits for concentricity and squareness before reassembly.

2. Note carefully the dimensions and clearances in all fits between mating parts. Any replacement parts must be made to preserve these fits.

3. If a new shaft has to be made, be careful to use shafting that will match the strength characteristics of the original shaft.

If something is improvised, keep an accurate record of what was done. This is especially true when the motor is not merely repaired but is modified to enable it to do its job better.

The motor manufacturer doesn't know anything about such field modifications, unless you tell him. If some subsequent motor failure involves these modifications, he won't know what the trouble is; and, of course, ordering a "duplicate" motor that turns out not to be a duplicate has strained more than one set of customer relations.

Proper Reassembly

When the motor is finally ready to be put back together, *reassemble it properly.* Most important thing here is to get all the parts back in their proper relationship to each other. Specifically:

1. Rotor assemblies in 3600-rpm motors, above 150 hp, usually have unidirectional blowers on one or both ends. Other rotors of many speeds and sizes have air baffles or shrouds on one end to direct the flow of ventilating air. Make sure that rotors and blowers are put back on shafts so that the proper air flow is maintained. Use the manufacturer's assembly drawings if there is any doubt. Even if air circulation is no problem, some rotors have special machining on one end to clear adjacent parts, such as explosion-proof seals or oversize bearing housings. If this isn't watched, there may be interference between the parts at final motor assembly.

2. Rotors must be located on shafts so as to align the rotor properly with the stator. Mislocation of half an inch may cause interference with adjacent parts in large motors; only one-fourth inch in a 2- or 3-hp motor can raise the magnetizing current 25 per cent and the full load amp by almost as much.

3. Double check for presence of weld spatter, metal chips, globules or copper from winding failures, and similar foreign matter in the frame, bearing housings, and other nooks and crannies inside the motor. If such stuff is left undetected and later gets loose inside the motor, it can do tremendous damage.

4. Make sure cement or other material originally used to seal fits between mating parts is cleaned out thoroughly and replaced with new sealant.

5. In vertical motors using angular contact ball thrust bearings, see that the bearing or bearings aren't put in upside down. Except for the "split inner race" type, such bearings will carry thrust loads in one direction only.

Perform Simple Tests

Finally, there are some simple tests that can be performed to be sure the assembled motor will run properly.

First, turn the rotor by hand to see that it rotates freely.

Second, check for proper end-play. Unless locked bearing assemblies are used, the end-play of a ball bearing motor should be about 0.005 inch for each inch of shaft length between bearings. With sleeve bearings, end-play ranges from $\frac{1}{32}$ to $\frac{1}{2}$ inch, depending on motor size and speed.

Third, check for uniformity in the air gap. If the data is available from the manufacturer, the amount of gap should be checked. In any case, be sure the gap is uniform within 10 per cent. Eccentric (and oversize) air gaps cause vibration and excessive currents; and undersize gap reduces torque and may allow the rotor to rub the stator.

Fourth, run the motor without load, and observe it closely. Listen for unusual noises. Measure the bearing housing temperature with a thermometer. If possible, check the no load current in all three phases. Ratio of average no load current to nameplate rated current should be about as shown in Fig. 3; all three line currents should be balanced within 10 per cent.

A check that is useful if a variable voltage source is available is a single phase test of induction motor rotors. Apply voltage between two of the three leads, sufficient to circulate approximately rated current. Then rotate the rotor and shaft slowly by hand, watching the ammeter for sudden fluctuations in current. These indicate open circuits somewhere in the rotor which might otherwise be undetected.

Fifth, check vibration. Use a hand vibrometer with a direct-reading dial indicator, or one of the reed type. Vibration at bearing housings or on the frame should not exceed 0.001 in.

For further details, refer to the full text of Underwriters' Laboratories' recommendations E32 on electric motors. THE END

WHAT CAUSES CORROSION IN THE CONDENSER STEAM SPACE?

R. A. WILSON OF ALLIS-CHALMERS HERE CONTINUES HIS EXPLANATION OF CONDENSER TUBE FAILURES. EROSION WAS DISCUSSED IN DECEMBER

STEAM-SIDE corrosion has occurred mostly in the aftercooler tubes of the steam jet air ejectors. Experience shows that this corrosion has been primarily due to carbon dioxide and acid constituents of steam. Drainage from aftercoolers with a pH of less than 4 and nitric acid present is cited as an example. In a few cases, Admiralty metal, arsenical copper or Muntz metal tubes would last for a period of only 15 months. In at least one of these cases copper nickel tubes have lasted approximately 10 years, with some carbon dioxide in the steam and condensate in the aftercooler.

It has been recognized for a long time that carbon dioxide has been the principal offender in attacking these tubes. One of the best solutions is to use an 18–8 stainless steel tube in the aftercooler. Aftercoolers with stainless tubes have been in service since 1937, with no reported failures. It seems that this is a good answer to the attack on the tubes.

Frequently inter- and aftercooler tubes are listed together in discussing this attack. There is no record of severe attack in the intercooler under any normal situation in power plant service.

Ammonia

The recent trend is toward the addition of ammonia to reduce the iron pick-up in the system. While this is very effective, it tends to increase steam-side corrosion of condenser tubes. To understand corrosion in the condenser steam space, the effects of ammonia in the system should be considered.

Ammonia gas, or a water solution of ammonia may cause stress corrosion cracking of Admiralty, aluminum, brass and a number of other copper alloys when oxygen, moisture, and stress are present. Light drawn arsenical copper and annealed 70–30 copper nickel alloy are considered almost immune to this attack. Admiralty metal and aluminum brass tubes should be used in the annealed condition. Damage can occur over a long period of time with an apparent low stress level. When this occurs at atmospheric conditions and particularly if the stresses are residual stresses, the process is sometimes called "season cracking." Moisture and oxygen are considered essential for such damage to occur.

Ammonia is so readily soluble in water that it is easily concentrated. The ammonia concentration that existed or caused trouble is hard to determine after an incident. It is the local concentration and not an average concentration that is important. Air cooling section of a condenser will contain oxygen and moisture, and if ammonia is present the possibility of stress corrosion cracking is present. This may occur during operation, but the writer thinks it is more apt to occur during non-operating periods.

Stress corrosion cracking can start from the water side of the tube during non-operating periods from ammonia generated from the decay of slime deposits or other organic deposits. Cleaning and drying the tubes at the time of a shut-down is a good precaution.

Water-ammonia solution will dissolve copper alloys. This may be a very dangerous form of attack, which has not received the attention it deserves. Water-ammonia solution in the presence of oxygen is very corrosive, and when it drops from one tube to the next, it may cause grooving or a general thinning. This attack has been blamed on carbon dioxide by the industry in many cases, since ammonia trouble has been so closely identified with stress corrosion cracking. Conditions are right for this type of attack in the air cooling section of a condenser if ammonia is added to the system.

Ammonia is a non-condensable gas at condenser pressures and temperatures, but it is very readily soluble in condensate below saturation temperature. Condensate is below the boiling point if non-condensables are present and the more non-condensable, the more condensate subcooling. Attack on Admiralty, aluminum brass, red brass, copper silicon alloys, and arsenical copper is at a high rate under the right conditions. At very low ammonia concentrations the copper nickels are supposed to have much better resistance to attack.

Ammonia, being a non-condensable, concentrates with the non-condensables. Unlike carbon dioxide, for example, it is very readily soluble in condensate with very little sub-

Fig. 1. Admiralty metal tube from air cooling section of condenser. Note thinning due to ammonia-bearing condensate. Rate of attack can be very high

cooling. Surprising concentrations can be found in the air cooling section of a condenser, under certain conditions. A good deaerating condenser operating under favorable conditions with a pH of 9 and an ammonia concentration of about 0.2 ppm in the hotwell may have 50 to 125 ppm ammonia in the condensate on tubes in the air cooling section.

Some past failures of tubes have been directly attributed to ammonia. Two cases are known where the tubes in the steam space cracked after several months of operation. These units had been shut down for a period of time and one of them, in a sugar mill in Cuba, was down during the off-season. This attack started on the steam side and was not confined to the air cooling section. Ammonia may have been present in the system from accident, from decay of organic material, or because it was put there during the shut-down period and caused the tubes to crack.

In two other cases cracking began on the steam side of tubes after about 14 years of operation. One of these units was equipped with Muntz metal tubes and the other with Admiralty. Cracking started from the outside in the air cooling section. It is assumed that this was caused by ammonia, but whether the major damage was done when the unit was standing idle or operating is not definite.

Ammonia attack may not always be recognized. There has been more trouble in condensers, with tube attack on the steam side in the air cooling section. In many cases this attack evidenced itself as a sort of grooved appearance of the tubes. It was, in effect, a general thinning of the wall through erosion by corrosive condensate.

Since carbon dioxide produced a similar attack in aftercoolers, it has frequently been said that this attack was caused by carbon dioxide. On occasion such tubes have been sent to laboratories for inspection and analysis, and carbonates have been found on these tubes, indicating that the attack was definitely caused by carbon dioxide corrosion. Such reports have indicated to water chemists that this was carbon dioxide attack and that they should counteract it by adding ammonia or amines or some neutralizing solution.

It is felt that this attack is due to the action of ammonia rather than carbon dioxide. For one thing, a leak occurring in this section allows water to leak in over the tubes from the circulating water side through the holes that were made before the leak was discovered. In some cases this attack has taken place in a period of 15 to 18 months and caused failures. The attack is felt to correspond to that described in a paper by Ernest B. Harrison in POWER PLANT ENGINEERING, June, 1944, page 87, entitled Corrosion of Condenser Tubes by Ammonia.

Beyond the Hotwell

Theoretically, the destructive attack of ammonia on condenser tubes is likely to occur, if it does occur, in the area beyond the hotwell in a deaerating condenser. In this area the steam and non-condensables are on the way to the air pumps and must be cooled so that the non-condensables can be pumped out of the condenser.

There will be a falling stream of condensate through the upcoming steam and non-condensables. Condensate from the top of the air cooling section will be cooled to the temperature of the air going to the vacuum pump. As this cooled condensate drops through the upcoming steam, it will be heated until it gets to the lowest tubes above the hotwell where it should be substantially at the steam temperature. As this cold condensate meets the hot gases and vapor, including ammonia, it is able to absorb the ammonia and in effect wash it from the gas and vapor stream into the liquid stream.

Now charged with ammonia, the condensate drops lower into the tube bundle where at some point, due to being heated, it will release its ammonia again to the rising steam. In effect, there is a reboiler condition that exists in this air cooling section. We see no particular evidence of the possibility of venting ammonia out of a system under these circumstances.

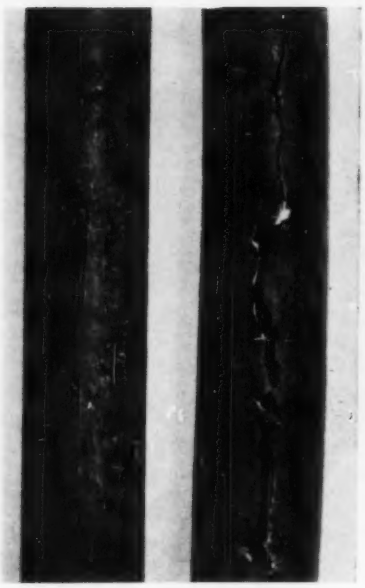
Some condensers built around 1917 and earlier had no air cooling section beyond the hotwell. In these units the condensate and non-condensables were removed from the bottom of the tube bank. These condensers could stand considerable ammonia. While the air and non-condensables were cooled and had the ability to absorb ammonia, it would be diluted in such a way that the concentration wouldn't be as high as in a reboiler section of a deaerating condenser.

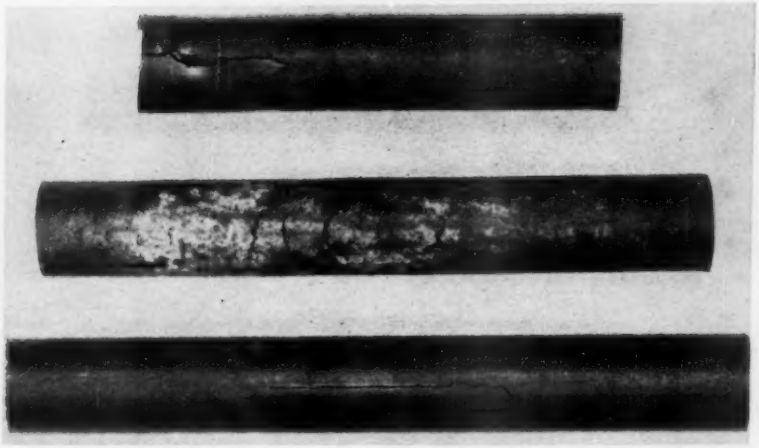
Such a condenser would not be satisfactory by today's standards because its condensate would contain tremendous amounts of oxygen and nitrogen and all the other non-condensables that might be in the stream. Such condensate would be very corrosive, and the copper pick-up would be very high, but it probably wouldn't eat holes in the condenser tubes.

Considering the above analysis, the places where the ammonia would tend to concentrate would change or move up and down in the air cooling section as the amount of air leakage changed. If the vacuum pump capacity is reduced or the air leakage is increased to the point where all of the surface beyond the hotwell is used for air cooling and there is considerable subcooling of the condensate leaving the main body of the condenser, then the ammonia might be washed out and diluted in the main body of the condenser. Thus it would stay in the hotwell instead of going into the air cooling section. This would make such a condenser operate essentially as did one of the early condensers mentioned above.

Some of the units that have had failures after a fairly short time have also operated at steady loads and with fairly low and very consistent air leakage. Number of tubes attacked was very low, since the reboiling effect and the concentration of ammonia were very much local-

Fig. 2. Admiralty tube from air cooling section. Grooving attack is typical of ammonia-bearing condensate but a thinned section may be smooth, uniform





Figs. 3–4. Aluminum and brass tubes from unit after two years of steady operation and 15 months of occasional operation. Admiralty, Muntz tubes show similar attack

ized. Some of the units that have operated for longer periods of time with no trouble to date may have the attack distributed over a great number of tubes, with the critical point varying from day to day and from hour to hour, depending on the air leakage, load and water temperature. This might indicate that when these tubes are found damaged there may be a considerable area of attack instead of something like 12 or 20 tubes, as has sometimes been the case.

How much ammonia should be used? From the above discussion it is evident that it is hard to predict just what would happen in any given case or how long ammonia can be used in certain concentrations without causing trouble. This is partly because ammonia is extremely soluble and has a tendency to concentrate at certain critical areas. This is dependent upon the air leakage and air removal of the system, and temperature distribution as discussed above.

Where ammonia is added to the system in carefully controlled amounts the danger appears to be less than with larger amounts of ammonia getting in accidentally. There are a number of units that have been using ammonia, or amines which may yield ammonia, for about eight years on a controlled feed basis. On the other hand, in some cases in 18 months there was considerable attack and tube failures caused by ammonia getting into the system in large quantities by mistake or due to operating errors.

There is some hazard in the use of ammonia under any circumstances, and there certainly is a hazard in having uncontrolled amounts of ammonia in the system. Uncontrolled addition of ammonia may occur in several ways. Any plant that has considerable condenser tube leakage will have uncontrolled addition of ammonia in the system. In practically all plants the raw water will contain organic material which will break down into ammonia in the boiler.

Thus, to control ammonia corrosion, condenser leakage must be controlled. Also, the use of water in the boiler that is treated with a corrosion inhibitor, such as the nitrites, can add appreciable quantities of ammonia to the system. Sodium nitrite in water used for testing the condenser and the boiler must be thrown away to prevent an accumulation of ammonia in the system when the plant is started after shutdown. Elimination should be accomplished in all ways practical, such as throwing away aftercooler drains, and with vigorous venting.

Using Amines

Advantage of using ammonia or amines to control pH and reduce iron corrosion is appreciated. It is helpful to the condensate piping, the steel parts of the condenser, the boiler and perhaps the turbines. There is a feeling in the industry that ammonia or amine pH control may help and certainly doesn't add to copper alloy corrosion if oxygen can be excluded. The sad fact is that oxygen cannot be eliminated from the air cooling section of the condenser.

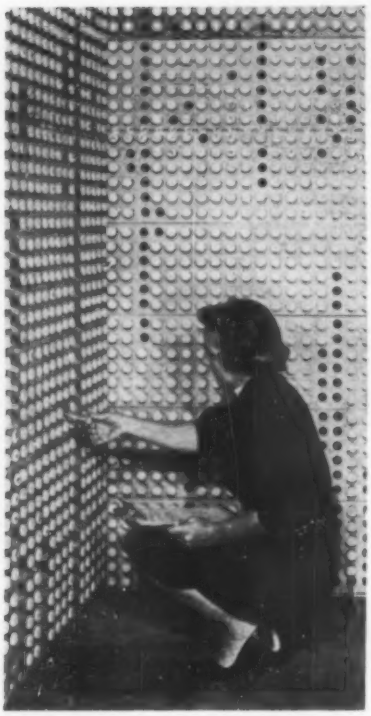
Amines are less harmful to copper alloys than ammonia in a given concentration. They are easier to get into the condensate in the primary condensing zone (without subcooling). They do not tend to concentrate as much in subcooled condensate as does ammonia. All of the amines will break down into ammonia. Extent of the breakdown will be influenced by temperature and pressure and perhaps other impurities present; thus the extent of breakdown may vary greatly with operating conditions. When amines are used, ammonia is present accidentally.

Ammonia is lost from the system through the aftercooler vent and through aftercooler drains if they are thrown away. Distribution of ammonia between the vents and drains will depend on the cooler design and capacity and innumerable operating conditions.

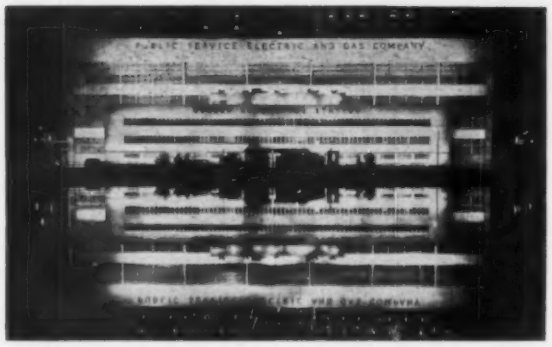
There are often good reasons for not returning aftercooler drains to the condenser, not considering their ammonia content. If ammonia gets into a system accidentally, throwing away aftercooler drains is helpful and may for practical purposes solve the problem. If pH control is by the addition of ammonia, amines or from hydrazine, throwing away aftercooler drains may reduce corrosion and change of tube failure. It is highly desirable although it may seem wasteful.

The place where chemicals are added and the manner of control are very important in considering the results on copper alloy material in the system. Experience of the last eight years where pH control has been used continually in many units indicates that the practice is not always as dangerous as some feared. Many units have no known evidence of ammonia failures or serious attack after six to eight years. This is reassuring.

The threat has prompted the use of stainless steel or stainless steel duplex tubes of several units, in the air cooling section. This seems to be a precaution which should be considered. THE END



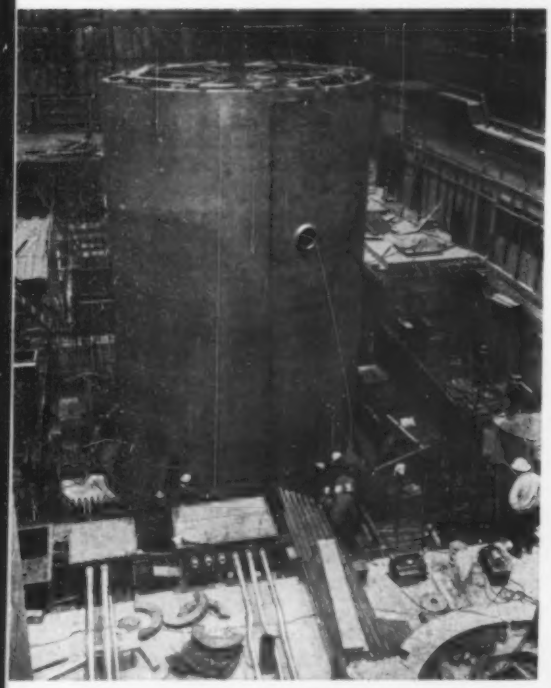
Tiny chokes used in electronic circuits are stored in wall at Nytronics, Inc, can be packaged 200,000 to a cubic foot



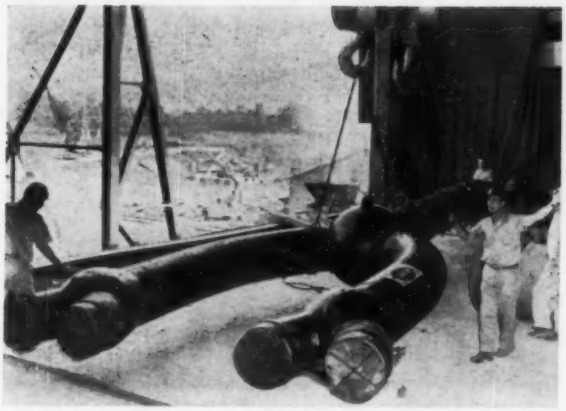
Brilliantly lit, the new $110 million Bergen Generating Station of Public Service Electric & Gas Co, at Ridgefield, N.J., makes a striking view for motorists on the New Jersey Turnpike. Mirrored in Overpeck Creek, administration building and turbine room are lighted to 10 and 14 footcandles

Power Engineering's

27 tons of Superior packaged boiler are raised to 14th floor of Brooklyn, N.Y., Union Gas building



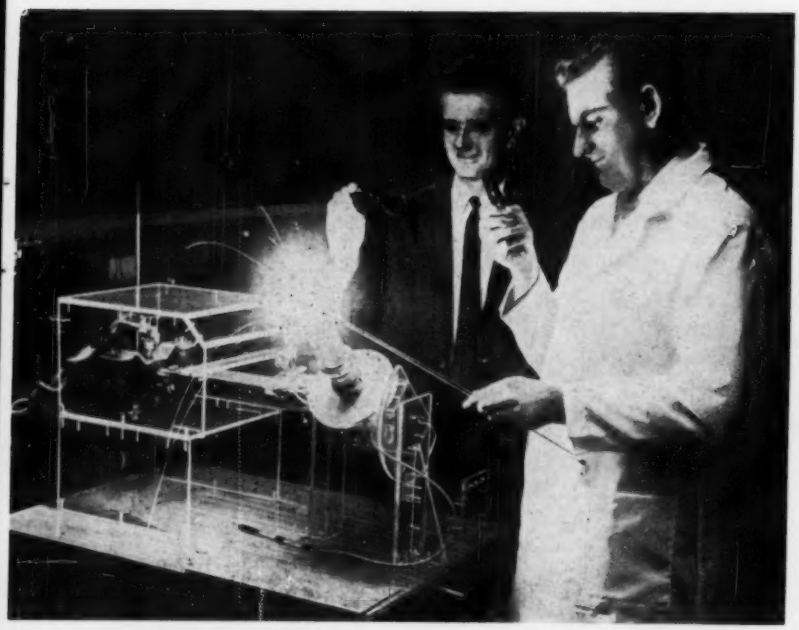
Reactor vessel for Hallam (Nebr.) atomic power plant is lowered into place. The 75,000-kw plant is using a sodium-cooled, graphite-moderated unit designed by Atomics International



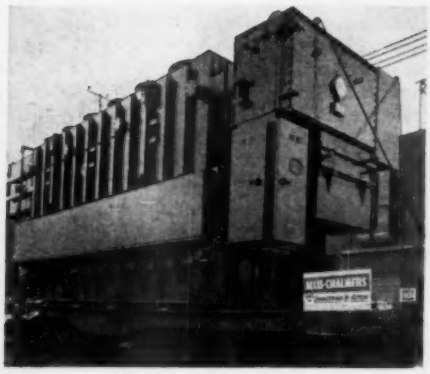
This 30-ft, 16-ton piping assembly, delivered in one piece, goes into the hot reheat system of Union Electric's Meramec Station unit No. 4. Midwest Piping fabricated it

NEWS REEL

Wire-stringing by Hiller helicopter saves time for Pacific Gas & Electric in building a 2.7-mile long powerline in mountain area. Thirty poles in the line were also placed by helicopter. This air-lift erection of line took only 10 hours



Plasma torch built by Amperex Electronic Corp uses an electromagnetic field to generate temperatures in excess of 3000 C. Here the torch is being used to melt steel in the lab



Bound for Commonwealth Edison's Crawford Station is this record-size transformer from Allis-Chalmers. It has an equivalent two winding capacity of 404,250 kva, weighs 673,000 lb installed, is 36 ft long, 18 wide, 19 high

UNIQUE HYDRO VALVE ARRANGEMENT SAVES SPACE

EDWIN W. MURPHY, HYDRAULIC EXPERT, TELLS HOW EBASCO AND ALLIS-CHALMERS SOLVED A TRICKY HYDRO PROBLEM

WATER STORAGE and flood control projects confront design engineers with many problems. Some of these have conventional solutions; others require application of new ideas to provide the best solutions.

In their study of a storage dam for the Carolina Power and Light Co's H. B. Robinson steam electric plant at Hartsville, S.C., the engineers at Ebasco Services met such a problem. This plant required a dam to provide storage water for the steam plant. The dam was built into a limited space, and *tainter* gates were built into its crest to provide spillway capacity for flood conditions.

In addition to providing for flood conditions, they were also required to provide a minimum downstream flow at all times. During high water periods, the tainter gates could be opened, and normal stream flow would pass through. In periods of low flow, it became imperative to regulate this flow accurately to conserve as much storage as possible, yet maintain the minimum flow requirements.

Regulation with gates is difficult, due to the large opening obtained with only slight movement of the gate. In addition, the regulation must continue even though head-water level may often fall below the sill of the gate. Under this condition, flow must be maintained by other means.

A "Howell-Bunger" valve was proposed as a solution to the regulation problem. This valve has a very high coefficient of discharge, and its rate of flow can be accurately computed for any head and for any opening between closed and full open. The valve can be positioned to the required opening to suit upstream water level and to regulate the discharge.

This type of valve plays an important role in the operation of the Robinson plant by serving as a means of purifying water discharged at the dam. This is accomplished when the discharge water passes through the valves and rises in a 15-ft cascade in the tailrace. The cascading effect adds oxygen to the water, thus further purifying it as it is discharged below the dam.

Locating a valve in the dam, sufficiently large to obtain the required discharge at low head, presented a new problem. Placing the valve opening in the spillway section of a tainter gate was out of the question. Such a location would subject valve and discharge chamber to severe damage when the gate was open and flood waters (with accompanying debris) were coming down over the dam.

Alternatives Considered

Alternatives were to place the valve at either end of the spillway, or between the tainter gates. Since the H-B valve discharge is in the form of a hollow cone, to break up the jet and dissipate its energy there should be ample space around it. The dam was located in a restricted area which would not permit use of a valve discharge chamber at either end. Only one place was left to locate the free discharge valve, and this was in the pier between the tainter gates.

Valve size, as determined by required flow at lowest head-water level, had certain fixed physical dimensions. It also had certain minimum clearances for installation and service. These dimensions, when used with the tainter gate pier, proved that a wider pier would be necessary. Since the space for spillway was so limited, use of a wider pier would require the gates to be reduced in length, thereby reducing the spillway capacity. This reduction could not be permitted, since the spillway then would not be large enough to provide capacity for maximum flood conditions in the stream.

Our engineers tried a new arrangement, using *two smaller valves instead of one large one.* To keep mounting width at a minimum in the small pier width, the two valves were placed in a vertical position. Fitting nicely into the limits of the pier, the valves are also protected from discharge through the gates over the spillway (Figure 2). Such an arrangement would cause the head on the upper valve to be less than on the lower. However, the reduced head was not serious since the combined discharge of the two valves at minimum head-level would still be sufficient to meet minimum flow.

Conventional type of operating mechanism consists of a screw stem on each side of the valve, driven by an enclosed worm gear, and connected by a special miter gear on top of the valve. This special miter gear is, in turn, connected by a vertical shaft to a drive mounted above. Because one valve would be above the others, no shaft could be used on the vertical center-line of the lower

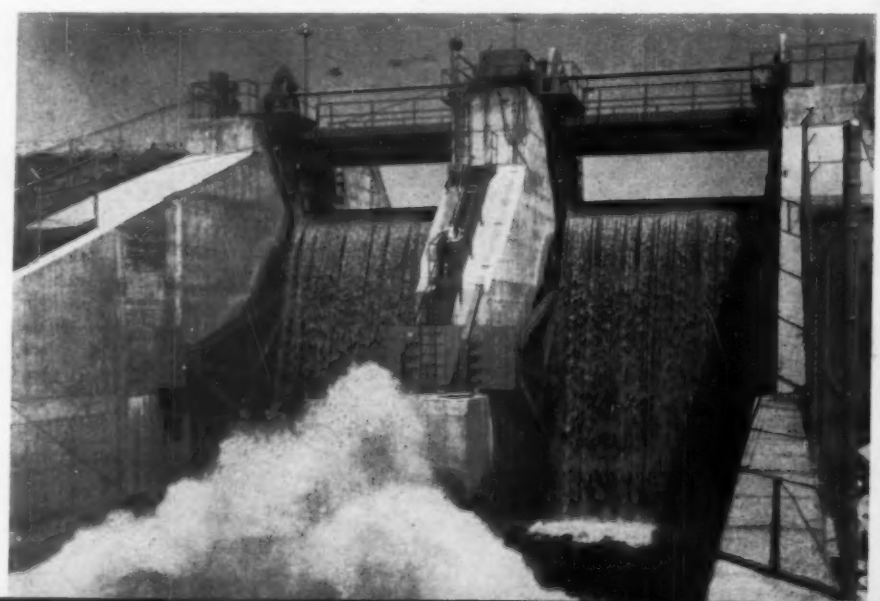
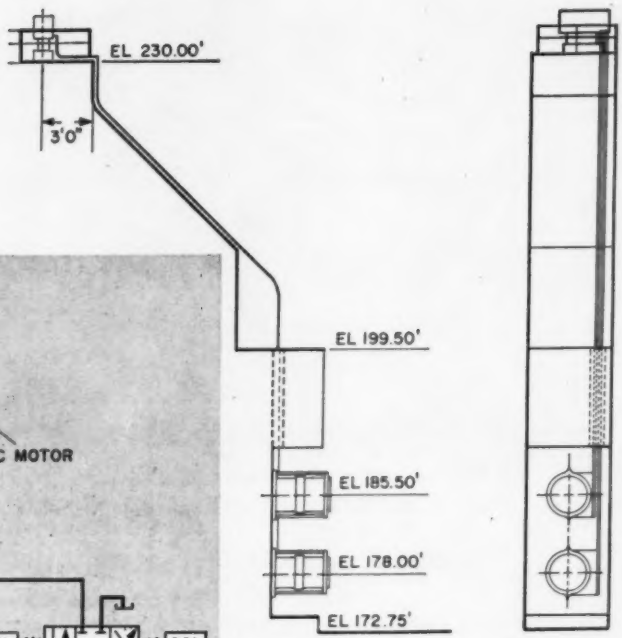
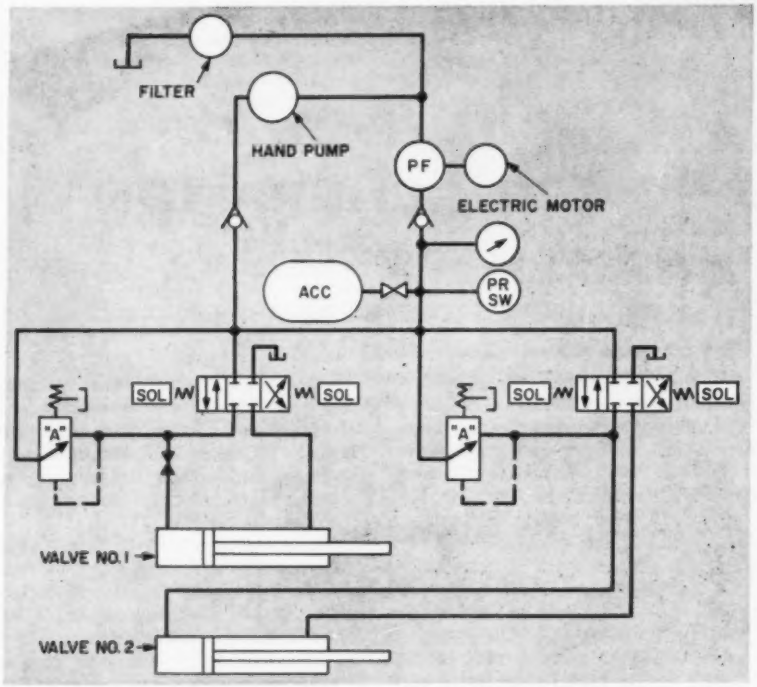


Fig. 1. Cascade of water is produced by the H-B valves installed in pier between the tainter gates. Cascading effect serves to purify water as it is released into the tailrace. Spillway structure is for the cooling lake at H. B. Robinson steam-electric plant

Fig. 2. (Right). Vertical section of the dam, showing placement of valves in spillway. Fig. 3. Schematic arrangement of the hydraulic pressure control system for operating valves





valve. With limited space for width, gear units on the side of the valve would stick out into the spillway and be subject to damage.

Since conventional operation was not satisfactory, the valves were modified for operation by use of two high-pressure hydraulic cylinders. The cylinders were mounted on vertical center-line, one above and one below each valve. It was then a simple matter to carry pressure to the cylinders with tubing connected to remote-control valves.

For this installation the pressure lines were carried to a point approximately 50 feet above the valves, where the pressure unit and controls could be conveniently located and be readily accessible. Through use of hydraulic cylinders, with oil as the fluid, the problem of frequent inspection and lubrication of the operating gearing was eliminated.

In operating the valves, it is necessary for the operator to know the exact position of each valve at all times so he can set the opening at the desired position — to give required discharge. With the valve located remotely from the control point, a position indicator of some type was needed. For this installation, a rheostat was mechanically connected to a moving part of the valve, so that motion of the valve was translated into a variable resistance in the rheostat. By connecting the rheostat to a voltmeter, and graduating it so that resistance was measured in terms of valve opening, a simple remote indicator was obtained.

Holding in Position

It is important to hold the valve in any set position between open and closed, and to hold it in closed position. With conventional valve-operating gearing, the self-locking screw stems provide these features. Using a hydraulic cylinder operator, with a control valve having blocked ports position, the oil can be trapped on both sides of the piston, thus preventing drift. Since the pressures on the H-B valve are almost balanced, there is little or no tendency for it to drift open — or closed. Blocking of both ports on the control valve will hold it in any position.

To hold the valve in its closed position it is necessary to apply pressure to keep it tight on its seat. Again, with a conventional geared mechanism, this is provided by the self-locking screw stem. When a hydraulic system is used, some sort of pressure-accumulator must be used, with an air cushion to provide elasticity and maintain compression in the oil line. Oil is practically non-elastic, so even a slight leakage past the piston will dissipate the pressure unless a replacement supply is provided to make up the leakage.

Figure 3 shows a schematic arrangement of the pressure-control for the valves. This control uses one pump and accumulator to provide pressure for two valves, each of which can be operated independently of the other.

For normal operation, the solenoid-operated control valve is moved to either open, or closed, position by energizing the solenoid through a pushbutton. This connects one side of the cylinders to pressure, and the other side to pump.

When the valve is closed and seated, with full pressure on the cylinders, auxiliary valve "A" opens to apply pressure from the tank directly to the cylinder and to maintain pressure to keep the valve tightly seated. Valve "A" will remain open after solenoid is de-energized and control valve returns to blocked-port position. Valve "A" will automatically close when the control valve is moved to connect cylinders for opening of the valve.

The installation described here provides an accurate means to regulate the flow of water through the valves at all times. THE END

GAS TURBINE POWER GENERATION

F. H. FORD, JR. AND J. K. HUBBARD, OF CLARK BROS. CO TURBO PRODUCTS DIVISION, EXPLAIN GAS TURBINE ECONOMIC ADVANTAGES

SINCE POWER generation is dependent upon rotary motion, it becomes axiomatic that the simpler the transition to this type of motion, the more reliable the power output. Turbo-machinery becomes a natural to this type of application and has proved itself time and again through steam turbines, hydraulic turbines, expansion turbines, and gas turbines.

In the past ten years gas turbines have recorded for themselves reliability factors exceeding those of many other prime movers. Particularly in installations where annual planned maintenance of all equipment has been enforced, the units have performed remarkably well, indicating availability approximating 100 per cent.

Installed Cost

The economics of the various prime movers which can be utilized will vary based upon location, type of building required, station auxiliary services, fuel availability, etc. In general, a gas turbine is a low capital cost prime mover and, when compared on an installed basis with other prime movers, will show an appreciable saving.

It is estimated that the installed cost of a steam or diesel plant will vary from 15 to 40 per cent more on a dollars-per-kilowatt basis than the cost of a comparable gas turbine plant. This has been represented graphically in Figure 1.

In any installation producing power, operating costs can normally be divided into major categories of fuel, operating personnel, utilities required, and maintenance.

Fuel costs represent the largest variable item, since each prime mover will have its own inherent efficiency; and further, the location of the prime mover relative to availability and fuel cost can make this of major or minor importance.

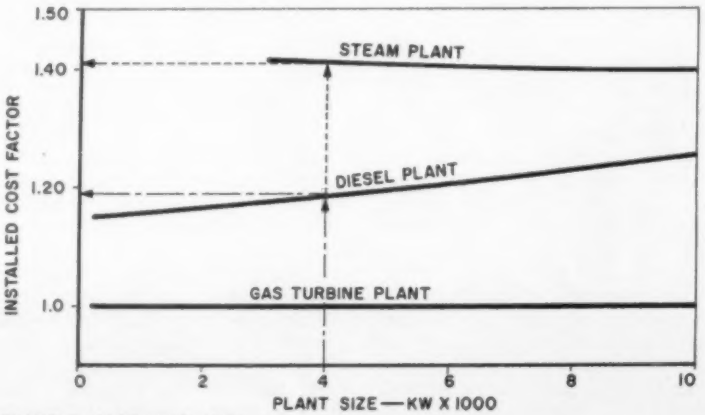
Other operating costs can be more readily established and grouped according to the prime mover and its power output. In Figure 2 it will be noted that the total operating cost of a steam or diesel plant, excluding fuel, will be approximately 60 to 80 per cent more than that of a gas turbine plant for average sizes. This factor in itself will normally be more than enough to offset the slightly higher fuel consumption of the gas turbine.

Gas turbine installations can be made even more attractive from an economic standpoint if advantage is taken of some of the inherent characteristics of the machine. In the proper climatic environment, gas turbines can be installed in a semi-protected area or even in some cases left completely unprotected. An open-sid- building of minimum cost and require ing minimum erection time can be utilized.

Ability of the gas turbine to be automated and operated from a central station or system control location offers further advantages to this type of installation. Automatic operation and monitoring have become proved methods of control. In industrial applications, units of up to 30,000 kw capacity are presently being operated from locations many miles distant from the installation with only periodic inspection of the unit.

One of the prime assets it has to offer is its ability to generate power and be on the line in a minimum time from a cold start.

The simplicity of design and the principles of all turbine machinery are exemplified in the low maintenance requirements of gas turbine



EXAMPLE: 4000 KW PLANT — THE APPROXIMATE INSTALLED COST OF A DIESEL PLANT WILL BE 19%, AND A STEAM PLANT 41% GREATER THAN A GAS TURBINE PLANT

Fig. 1. Chart shows the relative total installed cost vs size of the plant

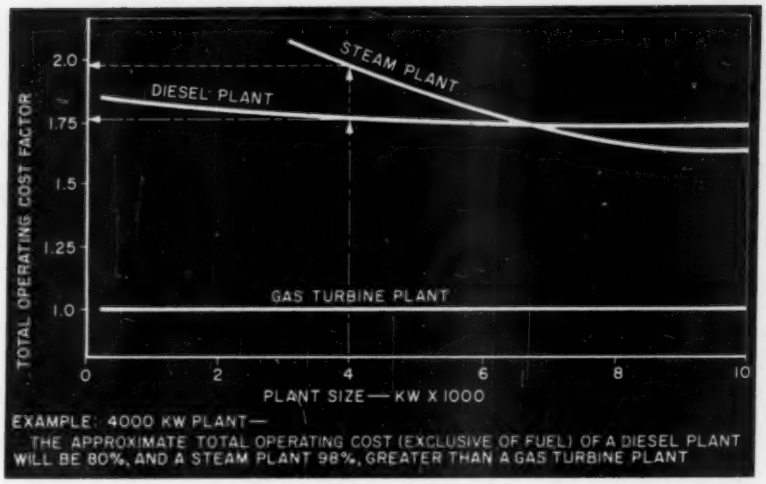


Fig. 2. Relative total operating cost (exclusive of fuel) vs size of the plant

prime movers. With gas turbine yearly maintenance costs, excluding labor, running approximately $1.00 to $1.30 per kw year, the comparison to the maintenance costs for other prime movers becomes very similar to the comparison of operating personnel required. Various sources and studies have indicated that gas turbine plant maintenance has been approximately 50 per cent of that of diesel or steam plants.

In a standard-type installation where the gas turbine generator set is controlled by a unitized control panel in the proximity of the unit, the operating personnel required is normally less than that required for other services within the same station. Experience has shown that any particular gas turbine installation in the medium to large sized units needs approximately one-third of the personnel required for a similar station with internal combustion engines.

This has also been substantiated by users representing more than 150,000 gas turbine horsepower and an equal amount of piston-type horsepower for compressor drive. Total labor costs for gas turbine installations has been less than 50 per cent of that for engine stations.

Fuel versatility is always an economic consideration and a balance between the amount of equipment required and the savings realized in purchasing various fuels. Units now developed are capable of operating on gaseous or liquid fuels and can change from one fuel to another while under load. With a minimum investment in an alternate fuel storage, extraordinary reliability can be assured through the use of a dual fired gas turbine.

Foundation Requirements

In power generation installations where the cost of foundation, buildings, connection of auxiliaries, and cost of installation can account for as much as 50 per cent of the total installed cost, it becomes obviously important to minimize these items.

In comparison to the structural requirements of a mammoth foundation capable of resisting the weight and impact loading of a piston-type engine, the gas turbine can be installed on a simple reinforced concrete mat or on a structural steel platform. Most industrial-type gas turbine units of the small and intermediate sizes are shipped from the manufacturer's plant on a common structural-type base, thereby minimizing field alignment and installation problems.

The lube oil requirements of a gas turbine are practically nil. The water requirement for cooling purposes can be eliminated by use of air coolers. Electric power requirement for accessories and auxiliaries — although very small to start with — can be, and usually is, further reduced by using shaft-driven accessories whenever possible. The economic and operating advantages over other prime movers with high lube oil consumption, excessive water requirements, large cooling towers, and need of appreciable amounts of auxiliary power become apparent.

Gas Turbine Cycles

Gas turbine components can be arranged in many ways to provide particularly desired characteristics, from the simple cycle to the complex compound cycle with intercooling, reheat, and waste heat recovery. Minimum of parts and complexity is associated with the greatest reliability and minimum first cost.

Simple cycle arrangement offers the best answer to the requirement for reliability, though in areas of high fuel costs its high fuel consumption might offset the savings in fixed costs shown previously. Fortunately for the gas turbine many installations have requirements for refrigeration and auxiliary drives that can be met by waste heat recovery. Losses in the gas turbine are almost completely contained in the exhaust and can be readily converted to useful energy by the addition of a waste heat steam generator.

This steam can be used for driving auxiliary pumps and fans as well as an absorption refrigeration system for site comfort cooling. Resulting gain in fuel utilization brings the total operating costs of the gas turbine plant to a level more than competitive with other prime movers.

Use of the regenerative cycle will reduce fuel consumption by over 30 to 50 per cent depending on the size of the heat exchanger employed. However, as no auxiliary energy is gained from the regenerator, fuel utilization is not as great as with the waste heat steam generator, and the first cost in dollars per effective kw is much higher. For these reasons it is not generally considered as a desirable cycle arrangement for other than large commercial stationary installations such as municipal power stations and gas transmission compressor stations.

Compound cycle employs two complete turbines with the flow in series from the low-pressure compressor through the high-pressure compressor, then expanding first through the high-pressure turbine thence through the low-pressure turbine. Low-pressure set is coupled to the generator while the high-pressure turbine drives only the high-pressure compressor. By the further addition of regeneration this cycle can be the equal of the diesel cycle in efficiency.

Obvious complexity and attendant high first cost in the smaller sizes eliminate this cycle from consideration, although for large commercial installations — say 20,000 kw — it becomes much more attractive to consider.

A trailer-mounted unit completely self-contained including generator, switchgear, and turbine controls can be built up to approximately 2500 kw within the legal load highway restrictions of most states. In rail cars, mounting units can be built to 7500 kw.

The gas turbine should never be discounted in any installation requiring power. Factors such as low initial cost, minimum operating personnel, and low maintenance cost are all in favor of the gas turbine. THE END

IOWA UTILITIES FIND MANY ADVANTAGES IN POWER POOL

SUCCESS OF THE POOL ARRANGEMENT IS DESCRIBED BY DUANE HAWTHORN, OF IOWA PUBLIC SERVICE COMPANY

ENGINEERING STUDIES, made by five Iowa power companies, indicated that considerable savings were possible by pooling the generation and transmission facilities of the group. Companies involved are: Iowa Electric Light and Power, Iowa-Illinois Gas and Electric, Iowa Power and Light, Iowa Public Service, and Iowa Southern Utilities. The decision to form this pool was made on July 1, 1958.

It was decided that the Iowa Pool, patterned somewhat after the Illinois-Missouri Pool, would operate without central control for administration, planning, and operation of the generation and transmission facilities. Instead, each company would individually control, and operate, its own facilities — as an integral part of the Pool operation. The Pool would be operated by various committees in which each of the five participants would be represented by its own personnel.

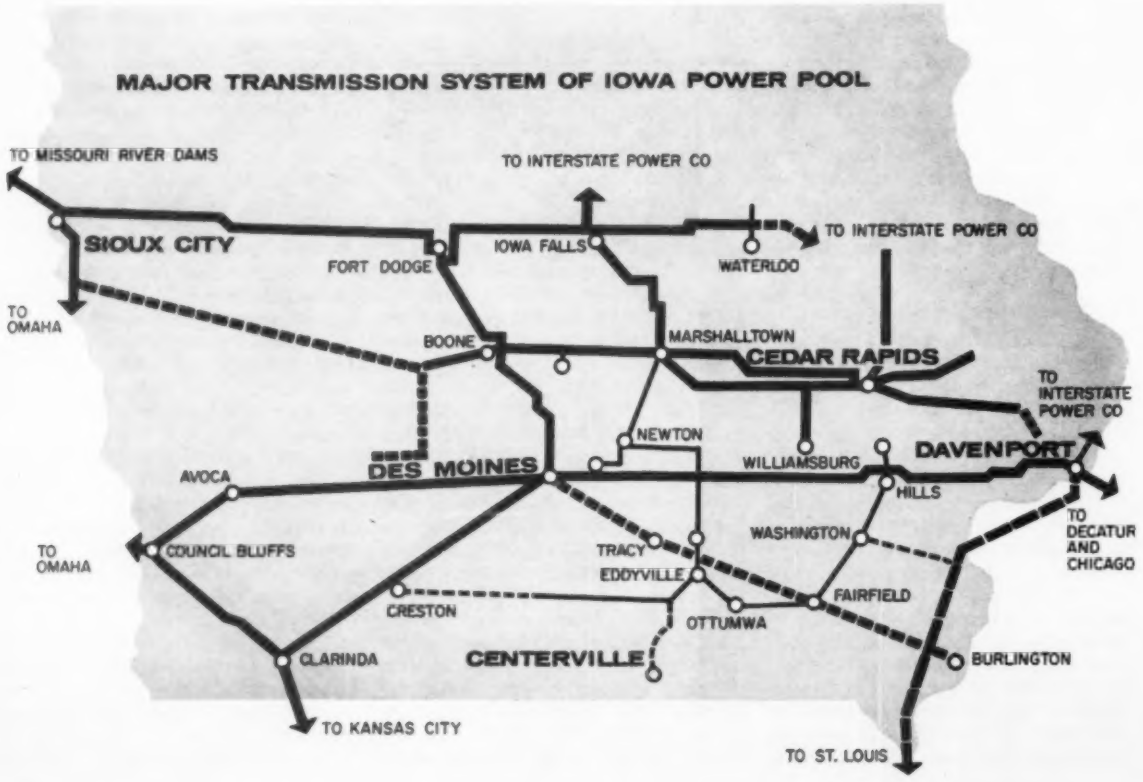
After two years of operation there is much evidence to prove the worthiness of the venture. With this type of operation, expenses incurred by the pooling operation are a minimum. Some extra traveling expense (by members of various committees), and some communication expenses, can be chargeable to the Pool operations. These are very nominal in comparison with costs of maintaining a central-control authority.

Committees set up by the Pool agreement are:

1. Administrative, to which all other committees are subordinate, and whose duties are to make all major (and long-range) decisions on operation and expansion of facilities; and 2. Operating, whose duties are to conduct the day-by-day operation of the Pool, and to report to the Administrative committee. To aid the above committees in executing their work, additional committees on Planning, Capacity Testing, Communications, and Relaying have been set up.

Savings which have already been realized are enumerated below:

1. Pooling spinning reserve. If each company were to carry enough spinning reserve for its largest single contingency, a total of about 250 Mw of spinning reserve



Typical Pool Operations for 22 Months

POOL INTERCHANGE			TRANSACTIONS WITH OTHERS		
MONTH	MWH		RECEIVED	DELIVERED	NET
July 58	716		26,895	259	−26,536
Aug	2,227		28,940	278	−28,662
Sept	4,918		36,608	0	−36,608
Oct	5,820		37,162	116	−37,046
Nov	9,425		14,908	147	−14,761
Dec	33,285		25,951	112	−25,839
Jan 59	41,163		23,319	744	−22,575
Feb	25,993		20,960	2,340	−18,620
March	19,618		13,702	1,991	−11,711
April	10,023		23,790	817	−22,973
May	5,967		28,392	707	−27,685
June	8,253		34,862	286	−34,576
July	3,740		47,266	104	−47,162
Aug	2,418		45,667	464	−45,203
Sept	7,157		46,864	796	−46,068
Oct	10,902		23,517	859	−22,559
Nov	28,848		38,668	4,773	−33,895
Dec	19,014		29,512	3,901	−25,611
Jan 60	27,939		41,881	4,868	−37,013
Feb	29,241		40,192	2,984	−37,208
March	25,114		39,013	4,748	−34,270
April	5,059		29,062	4,160	−24,902
TOTAL	326,840	35,596	697,131	35,454	−661,483

would be necessary. By pooling reserves, a total of 90 Mw is all that is needed. This represents annual savings of hundreds of thousands of dollars.

2. Interchange of energy during the first two years totaled 342,705 Mwh between the Pool members. The estimated average savings per Mwh is three-fourths mill, or an indicated annual savings of about $250,000. In addition, about twice that amount of energy has been interchanged between the Pool members and other neighboring utilities, as it is permissible for one member to act as "go-between" — with his non-pool neighbors and another Pool member.

3. Maintenance schedules are coördinated, making it possible (during major equipment outages) to continue service, without suffering economic loss caused from operating high-cost peaking equipment.

Future savings will include deferment of new plant construction (of 300 Mw) for two years, made possible by the pooling of reserve capacity. Each member need not maintain a reserve capacity in excess of its peak demand, as long as there is adequate reserve elsewhere in the Pool. A *deficient* member pays the surplus members a monthly capacity charge for the deficiency. In this manner a member can well afford to defer installation of new capacity and to justify much larger unit-sizes when the installation is made.

At the same time, total Pool reserves can be held to 10 or 15 per cent above peak demand, while the members benefit from lower installation and operating costs on units two or three times larger than could be possible on an individual company basis. (A 125-Mw unit is now under construction, and work on 150-Mw units will soon begin.)

Fuel savings, resulting from the installation of larger and more efficient units, will also produce more savings. Also, development of a coördinated communication system, which can be used for Pool business as well as individual company business, will increase efficiency.

Although *economic* savings are the easiest to measure, certainly the most important advantage the Pool offers our customers is the increased reliability of the total power system. The Pool has proved its worth on many occasions (during times of trouble) in neighboring systems, as well as inside the Pool.

Of course, there is the problem of operating such an organization in a way to assure full economy of production; but some unique features have been developed, which are tremendous aids to operation. A full-period, leased Teletype service was installed (on a trial basis) among the five dispatching offices located at Cedar Rapids, Davenport, Des Moines, Sioux City, and Centerville. It has since become an invaluable tool with which to market power, meet emergencies, and transmit all types of information pertaining to the Pool operation. It gives each participant a written record of every transaction.

To prepare schedules for the interchange of economy energy for the following day, a cost survey is put on the Teletype by each member, showing his expected incremental (and decremental) costs for various blocks of power. From this survey it is usually easy to see which participants should *buy*, and which should sell. Later in the day a summary of each member's schedules is put on the Teletype. This shows his scheduled interchange, native load, spinning reserve, and incremental (and decremental) costs, based on his scheduled generation for morning, afternoon, and evening loads.

In case any emergency energy is needed by any member, he needs only to call on the other Pool members for a certain total Mw replacement, and each will immediately deliver (from his spinning reserve) a predetermined amount, which has been calculated in proportion to his spinning-reserve responsibility. Spinning-reserve responsibility is proportionate to the ratio that each member's maximum native load demand bears to the total maximum Pool demand.

Another type of energy that can be scheduled is called *equalization energy*, and it is scheduled when a capacity deficiency exists in a member's system. It carries a fixed cost of five mills and must be scheduled at least twelve hours in advance.

With these methods, it is possible to attain central dispatch economies *without a central dispatching organization*. There is constant effort from the several committees to improve all phases of the Pool operation. The past two years indicate we have tremendous opportunities in continuing to develop an economical and reliable power pool in Iowa. What was only a dream a few years ago, when the first 161-kv transmission lines were built in Iowa, has become a very workable reality. THE END

DENSITY SWITCH DETECTS LEAKAGE FROM GAS-FILLED TRANSFORMERS

BEATRICE A. HICKS, DIRECTOR OF ENGINEERING

OF NEWARK CONTROLS COMPANY, DESCRIBES A NEW DEVICE

FOR WARNING OF LOSS OF GAS OR GAS-VAPOR COOLANT

LEAKAGE OF INERT gases and vapors used as coolants and insulation in power transformers need no longer wait for after-the-fact detection and location. Recent development of the gas density switch now makes possible early detection and remote indication of leakage in time to prevent critical loss of expensive gases or permanent damage to equipment.

During the last four years gas and gas/vapor-cooled power transformers have made steady progress. In 1956 two 2000-kva, 69-kv transformers were installed by the Consolidated Edison Company of New York. In July of 1958 a 7500-kva, 34.5-kv vapor-cooled unit was installed at the Baltimore Gas and Electric Company, and more recently a 10,000-kva, 69-kv gas-filled power transformer was put into operation by the Pennsylvania Power and Light Company at Allentown, Pennsylvania. All four power transformers use either sulfur hexafluoride or sulfur hexafluoride plus a fluorocarbon vapor as the insulating and cooling medium because of its high dielectric strength at moderate pressure and its resistance to decomposition.

Just recently, two 115-kv units rated 12,500 kva were shipped to Pacific Gas & Electric Co. Two others are under construction: one for Consolidated Edison, and one for Pacific.

In gas- and vapor-cooled units which use a mixture of sulfur hexafluoride gas and fluorocarbon vapor to serve as both the insulating and cooling medium, the vaporizable liquid is pumped from a sump at the bottom of the tank as a liquid.

Power transformers insulated and cooled with gas and vapors have many advantages over their predecessors using oil for this purpose. These artificial atmospheres are capable of great heat absorption and greater arc suppression; are nonflammable, non-toxic, lighter in weight and require less maintenance effort. However, hermetically sealed power transformers have the inherent problem of gas and vapor leakage which results in corona and increased heat. Heretofore this could be detected only by periodic physical checks, often after the problem became critical. Gas-filled transformers are, in addition, less noisy than oil-filled units.

Application

Leak detection tests should be made throughout the life cycle of the transformer; first, at point of manufacture to prove the integrity of the product before shipment; second, after shipment and during storage periods where it is desirable to ascertain the "good units," for purposes of maintenance or replacement; then, at the time of putting into service to locate possible trouble sources and prevent loss of installation time and cost, as well as to assure the operation of the equipment for immediate use. Finally, during operation of the transformer, a constant monitoring system is needed to indicate when a leak occurs.

The advantages of such a system are: detection of a dangerously low density of gas which might destroy the equipment or take it out of operation; alerting maintenance personnel that a leak exists; and saving expensive gases and vapors by early detection.

Arc-over is a function of molecular density and not of pressure which varies with temperature. In power transformers, arc-over occurs when there is a lowering of density due to gas or gas/vapor leakage.

Operating Principles

The switch operates either on a gas or gas/vapor density principle. A predetermined reference density of gas or gas/vapor is sealed within a bellows, and the exterior of the bel-

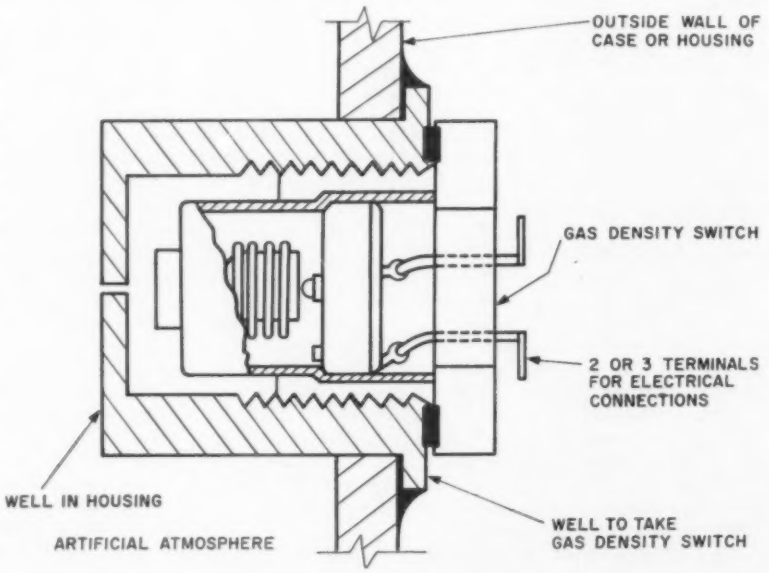

OUTSIDE WALL OF CASE OR HOUSING
GAS DENSITY SWITCH
2 OR 3 TERMINALS FOR ELECTRICAL CONNECTIONS
WELL IN HOUSING
ARTIFICIAL ATMOSPHERE
WELL TO TAKE GAS DENSITY SWITCH

Fig. 1. Schematic drawing showing the gas density switch as it is mounted on housing containing artificial atmosphere

lows is exposed to the artificial atmosphere within the sealed power transformer (Fig. 1). The bellows' internal pressure then follows the external pressure. When the external density falls below the reference density of the bellows, the switch actuates a remote indicating light, bell, or buzzer and gives a continuous signal of this drop. Conversely, if the external density surrounding the bellows is raised again, the switch will deactuate. This actuation or deactuation occurs when the two densities move out of balance. The bellows then extends or contracts far enough to operate an electrical snap action switch.

Unlike an absolute pressure switch, the density switch actuates along or parallel to any given pressure-temperature curve, provided that the temperature of the surrounding artificial atmosphere is the same as the temperature of the artificial atmosphere sealed within the bellows. The absolute pressure switch, on the other hand, actuates only at one pressure throughout a given temperature range and is not directly indicative of a leak.

Selection and Use

The selection of a density switch depends on two factors: the type of fill material used and the temperature-pressure range in which the switch will operate. First, establish the normal variation of the pressure of the medium or fill with temperature. For gas alone this is a straight line on a graph; two sets of data establish this. For gas with vapor the line is curved. Next, establish the desired bellows pressure-temperature line where the switch should signal a warning of gas leakage. The actuation line of the density switch when drawn on the graph should be below and parallel to the normal pressure-temperature line of the transformer fill making due allowance for temperature gradients in the transformer. Finally, check so that the deactuating curve of the switch is at or below the normal pressure curve since, after repair of the gas leak in the transformer housing, the transformer will be refilled and the density switch will deactuate when the pressure has been restored to normal.

When properly specified, the deactuation of the switch may be used to indicate that the transformer has been refilled to its normal gas density (Figs. 2 and 3). If only gases are used as the insulating medium, the pressure-temperature curve will be linear, and a gas density switch type SN-88 is advised. Sulfur hexafluoride is such a gas. However, if a gas/vapor mixture is employed, the pressure-temperature curve is non-linear, and a density switch type SN-98 is recommended. An example of a non-linear system is a sulfur hexafluoride-fluorochemical combination.

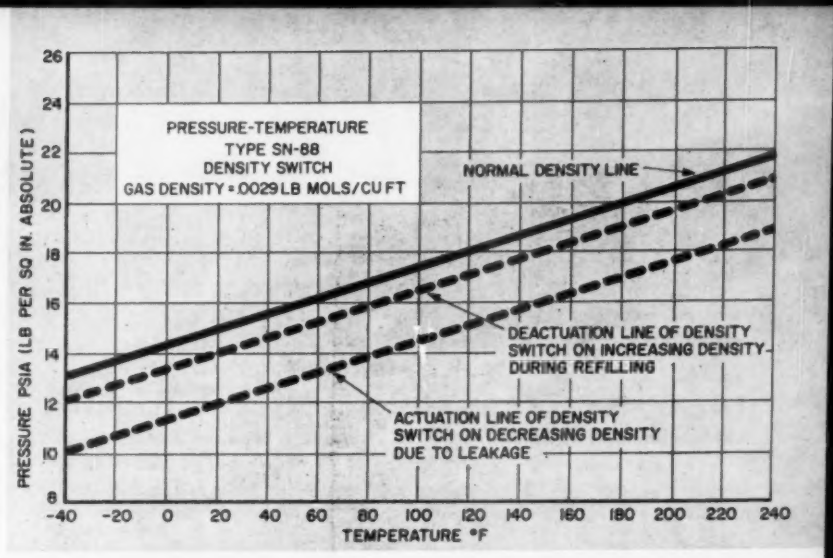


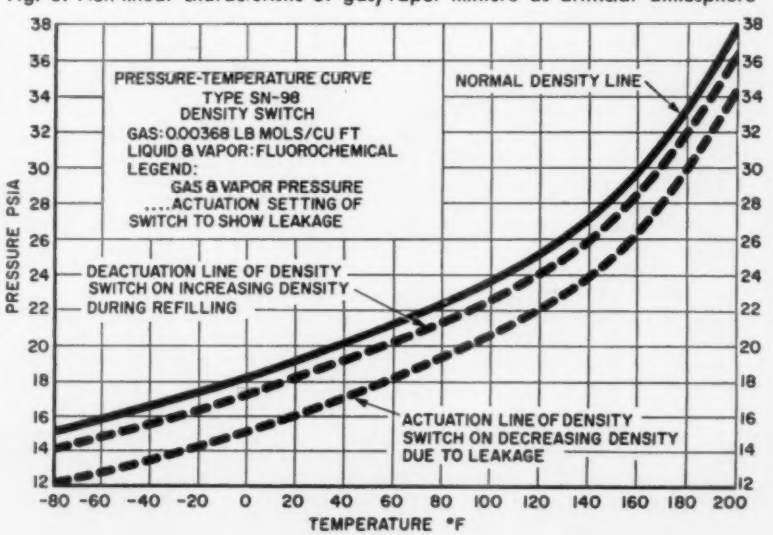
Fig. 2. Linear pressure-temperature curve, indicative of gas insulating medium

For purposes of protection the density switch should be installed in a covered well in the transformer housing where it cannot be accidentally knocked or stepped on (Fig. 1). The well should be covered and the switch mounted so that the temperature of the switch approaches the ambient temperature of the gas in the transformer. In addition to protecting the instrument, provision should be made for ease-of-maintenance. The very small orifice in the well limits the amount of gas that may escape should it become necessary to remove the density switch. A plug is then placed in the well.

With the gas density switch wired to a remote warning device, the power transformer is constantly monitored for leakage. On the job maintenance men receive an early warning when the transformer develops a leak. When the switch signals a leak, the next step is to determine where the leak is. This is done by using any one of a number of commercial leak detectors readily available.

The density switch used to monitor and to indicate that there is a leak and the halogen-type leak detector used to determine where the leak is solve the problem of indicating and detecting leakage in power transformers. Knowing both these facts at the time the leak occurs provides the service engineer with a powerful tool and allows him to make the necessary repairs quickly and easily, thereby preventing critical loss of expensive gas, loss of operating time due to repair down-time, and possible serious damage to the transformer. THE END

Fig. 3. Non-linear characteristic of gas/vapor mixture as artificial atmosphere



THE EXCITING FUTURE FOR POWER ENGINEERS

BY EDWIN VENNARD, MANAGING DIRECTOR OF THE EDISON ELECTRIC INSTITUTE

WELL-TRAINED ENGINEERS have been and will continue to be one of the most important keys to a dynamic American future. They are essential to our nation's economic growth and the increased well-being of our people in an atmosphere of freedom.

In less than 100 years the machine has revolutionized the way men live. Each U.S. production worker has the equivalent of 400 assistants in the form of electrically-driven machines. Machines have created new jobs and whole new industries. Machines have raised the average income and national standard of living, because they have enabled man to produce more with his limited energies. The average work week has been steadily decreasing, giving men more and more leisure time to devote to other pursuits that lead to a higher plane of civilization.

Role of the Power Engineer

Countless industries, households, farms and commercial businesses today make extensive use of machines dependent on the production of power to make them run. The United States is the world leader in electric power production. The industry in the U.S. produced over 700 billion kilowatt-hours of electricity in 1959 — more than three times the amount produced by the next-ranking country, Soviet Russia. Because we look forward to economic growth, the output of electric power must grow accordingly. A key man in this whole chain of operations is the power engineer. His future will be an exciting and important one.

It has been the pattern of the electric companies in the U.S. to double their power output about every ten years. As a stable and essential business the electric companies have every confidence in their ability to attract in the free market the $53 billion investment they will need to meet the expected demand for power by 1970. The 1959 electric company output of 569 billion kilowatt-hours is expected to more than double by 1970 and then to about double again by 1980.

It is difficult to guess how many young engineers will be needed to help do the job that is before the electric power industry. There are many possibilities for challenging careers that are open to young engineers interested in research and new concepts of power technology.

The electric companies are vigorously engaged in nuclear projects requiring the eventual investment of $650 million. The development of this field to the point where nuclear power is economically competitive with conventional fuels is one of the immediate challenges to the industry and to the vision and ability of its engineers. Countless engineering problems have to be re-examined in the light of each new development in this coming field.

Less publicized but very promising is the area of interest in "direct conversion." Research is being conducted into a variety of devices and processes for the generation of electricity directly from raw energy, such as heat, chemical and nuclear sources, without the use of such conventional equipment as turbines and generators. (See POWER ENGINEERING, Jan. 1961, special section on power research.)

One success in this area in the experimental stage has been a device making use of the principle of magnetohydrodynamics (MHD). This involves the passing of an ionized gas through a magnetic field to produce electricity. The MHD system may not become practicable and competitive with conventional equipment for many years, but the possibility of eliminating expensive equipment from the present methods might eventually represent a real breakthrough.

Record of the Power Engineer

The electric light and power business has been one to challenge the imagination and the ingenuity of all types of engineers. Electric company engineers have been, in large part, responsible for the success of the industry and for its great influence on the American way of living. Increased efficiencies and the simultaneous increased use have brought about a steady decrease in the price of electricity. Thirty-five years ago the average cost to the customer per kwh sold was 2.71 cents. Today it is 1.69 cents. The average price of household electricity today is only 30 per cent of what it was in 1913, while the cost of living is nearly three times what it was then.

Here are a few of the ways in which the power company engineers have helped the industry grow and prosper:

In 1892 it took about eight pounds of coal to make a kilowatt-hour of electricity. The new, large, high-pressure and high-temperature units can now make a kilowatt-hour with less than three-fourths of a pound of coal.

Technical advances have increased the maximum size of the generating unit from 32,500 kilowatts — big enough to serve 45,000 people — in 1920 to 500,000 kilowatts — capable of serving 700,000 people — in 1960. There is presently an 800,000-kw unit on order (see page 46, this issue). The large generators are more efficient to operate and cost less per kilowatt to build and install.

Increasing Efficiency

The use of steam turbines that run at higher temperatures and pressures also increases plant efficiency. Maximum temperature in 1916 was 650 F and in 1960 it is 1200 F. Maximum pressure during the same period rose from 350 psi to 5000 psi in 1960.

Transmission line voltages have likewise been raised. There is a test line under construction at Pittsfield, Mass., that will be operated at 750,000 volts. At the end of 1958 the U.S. had about 250,000 miles of transmission lines of 35,000 volts and above. The second-ranking country, the USSR, in the same year had 50,450 miles of transmission lines of 35,000 volts and above.

Efficient interconnection and pooling of facilities have helped make electric power more economical and more dependable.

All these problems have been solved by well-trained and inventive engineers who have been familiar with the achievements of the past but have known how to use them to build for the future. Power companies need more such men every year to help solve the unforeseen obstacles to their necessary growth. They need engineers in sales who can understand the problems of new customers and new industries and help them to use electricity in the way that will benefit them most.

Here are some specific examples of the many engineering fields in the power business:

Engineering design: Power com-

panies never build the same plant twice; the trend is toward larger and larger units. Here the power company engineers work closely with engineers of manufacturing companies. Each step forward brings new engineering problems that have to be worked out. The civil engineer, as well as the expert in fluid mechanics, may be interested in hydroelectric projects.

Operating engineers: Not all the needs for skill and intelligence are met merely by the design of the equipment. In handling this complicated equipment which may affect hundreds of thousands of people there is need for a high degree of skill and keen, mature judgment.

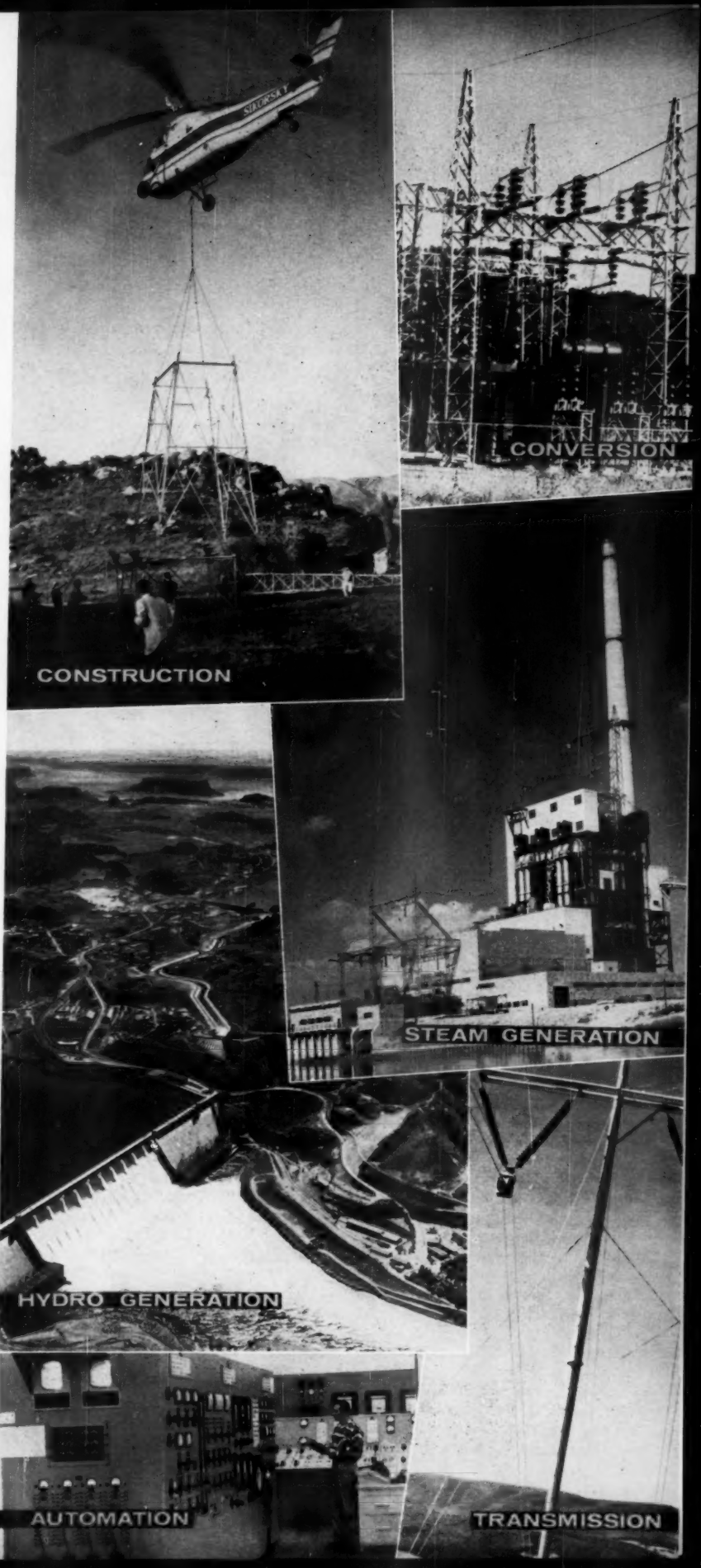
Research: In recent years the importance of research and its relation to company growth have been emphasized. The electric power industry could not have achieved its growth record without a broad program of research. The engineer or scientist interested in research, including research into the problems presented by nuclear energy, will find in the electric industry projects to test his ingenuity to the fullest and fire his imagination.

Economics and system planning: Before any of the other activities take place, someone has to figure out if they are worth while, and if so, when and where they are needed. How the various parts fit into the whole also merits considerable study, and gives the key to economical and efficient operation. These top-level policy problems fall under the broad headings of economics and system planning, and embrace such things as cost studies, forecasts, cost analyses, and rate design.

Sales engineering: In order to get people to use more electricity, the power company often has to help its customers with their own engineering problems as part of the sales job. This gives the engineer who likes people an opportunity to take advantage of both his brainpower and his natural inclinations. The problems he is likely to run into will vary widely.

Safety engineering: As the size and capacity of the various system components increase, safety problems increase also. Right now, the industry is working on many of the problems of safety in connection with nuclear power stations. Answers to some of the questions involved can speed the development of nuclear electricity.

It is not surprising that the varied responsibilities and practical know-how gained by young engineers in the power industry grooms many of them for important managerial jobs. About half of the major executives of power companies are engineers. THE END



MAGNETIC PROTECTION EQUIPMENT FOR COAL-HANDLING SYSTEMS

H. W. BUUS, STEARNS MAGNETIC PRODUCTS DIRECTOR OF R & D, TELLS

HOW TO SELECT PROPER EQUIPMENT FOR REMOVAL OF TRAMP IRON

SELECTION of proper magnetic protection equipment for a specific coal-handling operation is relatively complicated due to the number of variables involved. This article explains some of the problems involved and ways in which those in the business of engineering separation equipment for coal-handling use can be of service to you.

Relatively small pieces of tramp iron "junk" can put crushers out of operation, while a piece as small as a half-inch nut can seriously damage a pulverizer. Regardless of the care taken at the mine, a surprising amount of tramp iron can creep into coal during transportation and handling. Experience has shown that the only positive way of removing tramp iron is through the use of properly applied magnetic separation equipment at the plant where the coal is used.

Basic Types of Equipment

Suspended electromagnets, available in either rectangular or circular styles, are by far the most commonly used separators in power plant systems. As shown in Fig. 1, they can be suspended at any convenient point over a conveyor, or, better yet, angled over the conveyor head pulley. Circular suspended units are rarely used today because of the efficiency advantages of the rectangular style.

Automatic self-cleaning suspended units, illustrated in Fig. 2, perform in much the same way as standard suspended magnets. In addition, however, they provide completely automatic operation with continuous discharge of tramp metal, which eliminates the necessity of periodically stopping the system to remove accumulated material. Also, in the event of power failure, these automatic units will not drop an accumulation of tramp iron onto the belt. The particular unit shown is called a para-belt. An allied type of self-cleaning unit, called the cross-belt, discharges tramp iron to either side of the conveyor belt.

Magnetic pulleys are of the permanent magnetic or electromagnetic type and are usually employed where space limitations prevent the installation of suspended-type magnets. They are simpler to install, and, because of the gravity advantage, lower blanket magnetic intensity is required for any given system. A serious disadvantage is that in some systems, where fine coal with a certain amount of moisture is being conveyed, some of the coal adheres to the belt rather than following the normal trajectory and is discharged with the tramp metal. Figure 3 shows a schematic of the principle of operation.

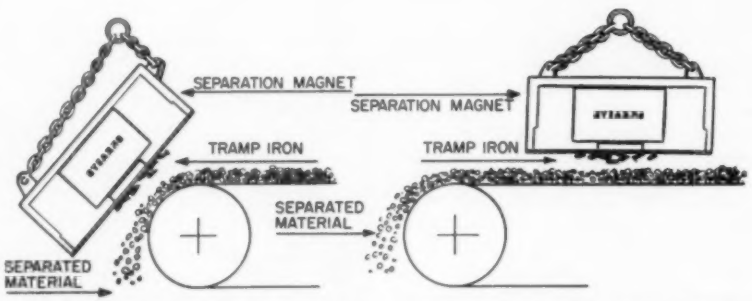


Fig. 1. Rectangular suspended electromagnetic units illustrated in the two basic mounting positions. Angled mounting is generally preferable to parallel method

Selection of Magnets

The data that follows is based on the application of all types of suspended magnets to standard 20 degree troughed conveyors. We have found it advisable to classify the selection of magnet size for four possible installations:

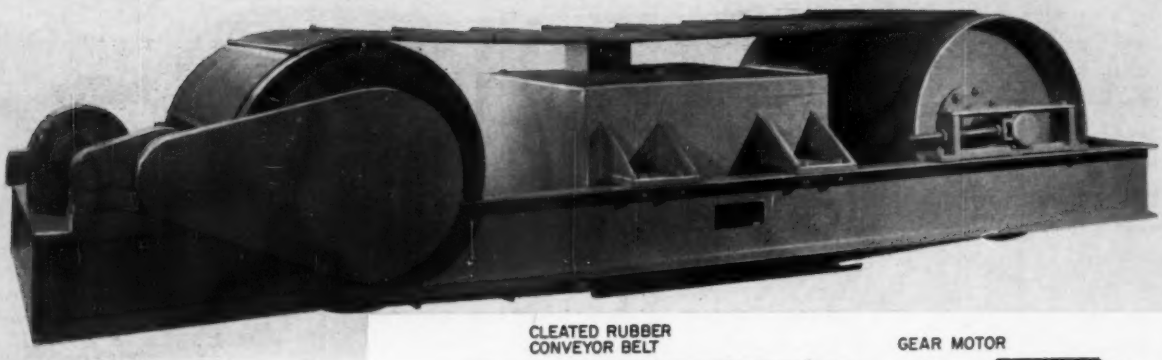
For protection of a crusher only the larger and more damaging pieces of tramp metal must be removed. This includes tramp iron which is of a general shape and size larger than 1″ × 1″ × 4″. Two possible conditions are: 1. magnet installed parallel over the conveyor belt, and 2. magnet tilted over the head pulley of the conveyor.

For pulverizer protection also we have the same two conditions: magnet installed parallel over conveyor belt, or magnet tilted over the head pulley. But tramp metal as small as ½-in. nuts must be removed.

Specific operating conditions which influence the selection of the size of suspended magnet separators are: belt width, belt speed, capacity or volume, maximum lump size, nominal burden depth, mounting position, and minimum size tramp iron to be separated.

One of the most important factors in selection of magnet size is the width of the conveyor belt which determines the width of the magnet to be used. It is usually recommended that magnet width be equal to belt width. Because magnetic flux density at most normal suspension heights tapers off across the width of the magnet, it is necessary to select a magnet wider than the actual burden in order to assure uniform magnetic strength across the entire burden width.

Next, the required height of suspension must be determined. This is established either by the maximum lump size or the average depth of material carried upon the conveyor belt, whichever is larger. Then, approximately 3 to 4 inches are added to this dimension to determine the actual required suspension height. For purposes of material depth calculation, we are assuming the effective material width to be approxi-



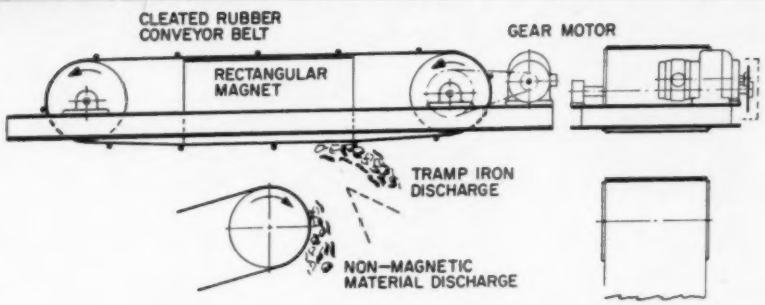


Fig. 2. Above picture shows para-belt type of self-cleaning suspended magnet. Schematic shows preferred mounting position, angled over head pulley

mately ⅝ of the actual belt width.

Nominal burden depth, or height of burden in the center of a troughed conveyor belt, can be determined by the following formula. This formula takes into account the effective material width and gives the depth in inches at the center of the conveyor belt:

$$De = 25.2 \frac{C}{W \quad V}$$

Where:
De = center burden depth in inches on a 20 degree troughed conveyor
C = capacity or volume in cu ft per min
W = actual width of belt in feet
V = velocity or belt speed in ft per min

Example:
C = 300 cfm of minus 2-inch coal
W = 3 feet
V = 400 fpm

$$De = 25.2 \times \frac{300}{3 \times 400} = 6.3 \text{ in. nominal burden depth}$$

Since average material depth is larger than maximum coal size, this becomes the determining factor as to suspension height. By adding 3 to 4 inches for material clearance, the total suspension height will be about 10 inches above the belt surface. Thus a 36-inch-wide magnet is required, mounted at a suspension height of 10 inches above the bottom of the material burden.

Conditions which determine the magnetic strength required are as follows: First, whether the magnet will be suspended tilted over the head pulley or parallel over the conveyor belt.

Second, minimum size of tramp iron to be extracted.

Third, belt speed of the conveyor or speed of the material. Belt speed is especially important if magnet is mounted parallel over the conveyor belt. If mounted tilted over the head pulley, speed is less important, since momentum of the material to be extracted is in the general direction of extraction.

Fourth factor is the average depth of the burden through which the tramp iron must be extracted. Effect of burden depth is considerably greater with the magnet mounted parallel over the conveyor belt than with it angled over the head pulley. With the magnet angled over the head pulley, the material has a tendency to fall away and open up as it cascades over the pulley, thereby presenting greater voids through which the tramp iron can be extracted with less hindrance from the material burden.

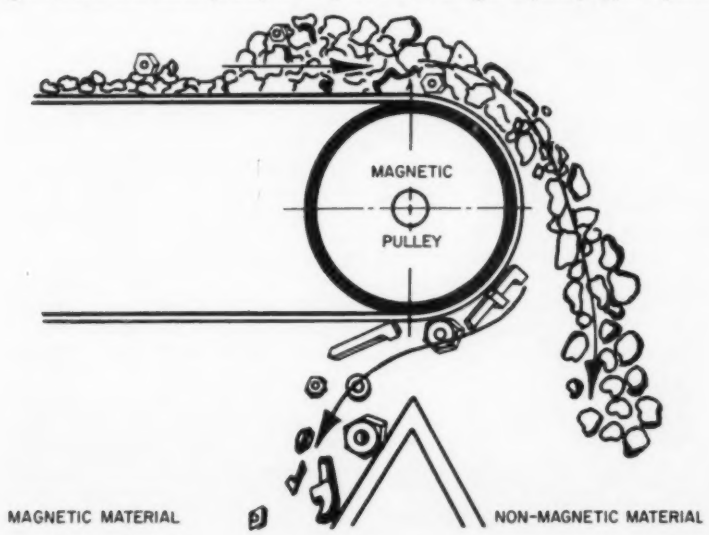
These four separation conditions have been rated according to difficulty of separation and will determine the strength of the magnet required within any given size range. Figure 4 may be used for this determination.

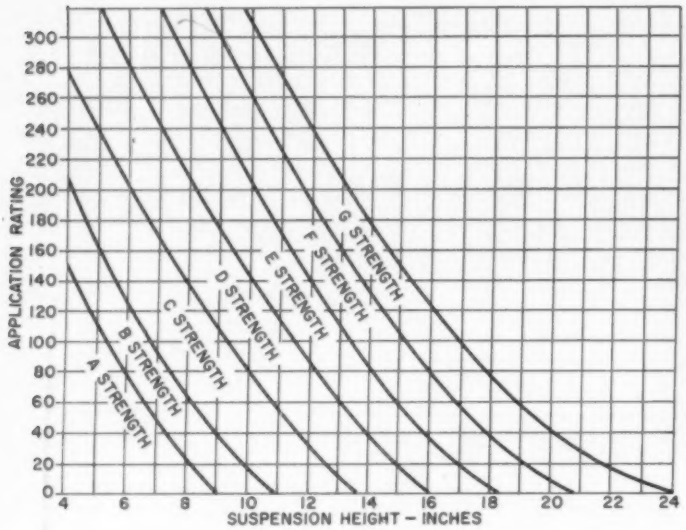
Utilizing the same example used for calculation of burden depth, we shall assume that the magnet can be mounted tilted over the head pulley and that it is to be used for pulverizer protection, and therefore must remove all tramp iron down to ½-in. size.

Example (refer to Fig. 4):	
Minimum size tramp iron, rating	80
Belt speed of 400 fpm, rating	0
Average burden depth 6.3 in. rating	30
Total Rating	110

Intersection of the 110 application rating line and the 10-in. suspension height line on the chart in Fig. 4

Fig. 3. Schematic shows principle of operation of magnetic pulley-type separator





INSTALLATION FACTORS	SUSPENSION POSITION	
	PARALLEL OVER BELT	TILTED OVER PULLEY
MINIMUM SIZE TRAMP IRON		
LESS THAN 1/2"	100	80
1/2" TO 1"	60	50
1" TO 2"	30	20
2" TO 4"	10	5
OVER 4"	0	0
BELT SPEED - FPM		
0 - 350	20	0
350 - 500	40	0
500 - 650	60	10
OVER 650	80	20
AVERAGE BURDEN DEPTH		
0 TO 3"	20	0
3 TO 6"	40	10
6 TO 9"	60	30
9 TO 12"	80	60
OVER 12"	100	80

Fig. 4. Typical rating chart for the selection of rectangular suspended magnets

indicates that a D strength magnet is required for this job.

Automatic suspended self-cleaning type separators may be selected similarly. A cross-belt separator would involve the same procedure as a rectangular suspended magnet mounted parallel over the conveyor belt. A para-belt self-cleaning separator would have the same conditions of application as a rectangular suspended magnet mounted tilted over the head pulley. Calculated suspension heights of these magnets would be determined by the same method.

Selection of Pulleys

Recent developments in new ceramic magnet materials have made it possible for the first time to build permanent pulleys which are, size for size, the equal of electromagnetic units. At present, permanent pulleys employing this new material are available in diameters up to 48 in. for belt speeds up to 435 ft per minute. However, in the larger conveyor systems, where belt sizes and speeds are extreme, electromagnetic equipment is the only answer at present.

Required pulley size can be selected from the typical chart shown in Fig. 5. For normal operation, simply select belt width and locate capacity equal to or next larger than required. Then read off pulley diameter and normal belt speed.

If faster belt speed is required, determine difference between the required belt speed and normal belt speed just found. Add one-half of the difference to this normal speed to obtain corrected speed factor. From table, pick diameter of pulley corresponding to this new speed.

Belt conveyors inclined upward on the approach to the magnetic head pulley can be operated at faster belt speeds and increased capacities. Table B in Fig. 5 gives correction factors which apply to both speed and capacity.

Example: 48-in. width conveyor belt
Capacity: 33,000 cu ft per hr
Required speed: 425 fpm
Conveyor inclination: 15 degrees

0.865 x 33,000 = 28,545 corrected capacity
0.865 x 425 = 367 corrected speed
Selected pulley diam: 30 inches; recommended speed: 330 fpm

$$\frac{367 - 330}{2} + 330 = 349$$

A 36-in. diam x 48-in. width pulley should be used.

Fig. 5. Use of these typical design tables is explained in text of the article

TABLE A. MAGNETIC PULLEY CAPACITIES

Pulley Dia. Inches	Width of Belt												Normal Belt Speed F.P.M.
	12" Cu. Ft.	14" Cu. Ft.	16" Cu. Ft.	18" Cu. Ft.	20" Cu. Ft.	24" Cu. Ft.	30" Cu. Ft.	36" Cu. Ft.	42" Cu. Ft.	48" Cu. Ft.	54" Cu. Ft.	60" Cu. Ft.	
12	790	1080	1460	1880	2330	3500	—	—	—	—	—	—	175
15	900	1240	1670	2150	2660	4000	6300	—	—	—	—	—	200
18	1010	1390	1880	2420	3000	4500	7100	10500	—	—	—	—	225
20	—	1550	2090	2690	3330	5000	7900	11700	16600	—	—	—	250
24	—	—	2300	3060	3800	5700	9000	13300	19000	26200	—	—	285
30	—	—	—	3540	4400	6600	10400	15400	22000	30400	—	—	330
36	—	—	—	—	4960	7300	11500	17000	24300	33600	43300	—	365
42	—	—	—	—	—	8000	12600	18700	26700	36800	47500	59000	400
48	—	—	—	—	—	8700	13600	20300	29000	40000	51600	64200	435
54	—	—	—	—	—	—	—	22200	31700	43700	56400	70100	475
60	—	—	—	—	—	—	—	—	33300	46000	59300	73800	500

TABLE B. CONVERSION FACTORS FOR INCLINED CONVEYOR BELTS

Degrees Incline	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Correction Factor	955	946	937	928	919	910	901	892	883	874	865	856	847	838	829	820

Power Consumption

Direct current power supply to the coils of electromagnetic units is usually handled through a selenium rectifier. However, in recent years silicon rectifiers have become more popular and extremely reliable.

Power consumption of electromagnetic suspended separators varies according to the strength required for any given width. Electromagnetic pulleys range from 12 to 60-in. diameters and require proportionately increasing power ranging from 350 watts to 8300 watts, respectively.

Physical shape of the tramp iron expected to be encountered and separated has a very definite bearing upon the size of magnet and suspension height required. It appears that any magnet under 600 gausses at the belt under continuous operating conditions could allow a damaging piece of tramp iron to escape.

Therefore it is generally recommended that for normal continuous tramp iron separation, with the magnet suspended directly over the conveyor belt, that a unit be selected which will produce at least 600 gausses at the belt surface at the required suspension height. THE END

Editor's Note: *For more information on electromagnetic and permanent magnet separation equipment, please write* The Editor, POWER ENGINEERING, 308 E. James St, Barrington, Ill.

Power Engineering

U.S. CALLS FOR PARTICIPATION IN '62 WORLD POWER CONFERENCE

FRANCIS L. ADAMS, CHIEF OF THE POWER BUREAU, FEDERAL POWER COMMISSION, AND CHAIRMAN OF WPC'S U.S. NATIONAL COMMITTEE, HERE DESCRIBES PROGRAM OF THE SIXTH WPC, TO BE HELD IN AUSTRALIA

UNITED STATES National Committee of the World Power Conference has recently been informed by the Australian National Committee that the United States has been allotted 20 technical papers for the Sixth Plenary Meeting of the Conference to be held in Melbourne, Australia, October 20–26, 1962. Planning must begin now to assure good attendance and effective participation by the United States in the work of the Conference. The first task of the National Committee is the selection of authors and subjects for the technical papers to be submitted by the United States.

Theme and Topics

The 1962 Plenary Meeting will develop a timely theme, The Changing Pattern of Power, by emphasizing the changes that have taken place in all power production, transportation and utilization techniques since the Fifth Plenary Meeting in 1956, and by including forecasts of expected future developments. The papers and discussions will be grouped as follows:

Division I provides for (a) discussion of energy resources based on the World Power Conference Survey of Energy Resources and the United Nations annual statistics on world energy supplies, and (b) national surveys prepared by each National Committee dealing with past and expected future developments in the exploitation and use of all primary sources of energy.

Division II provides for papers dealing with the production and amelioration of primary sources of energy, particularly solid, liquid, gaseous, and nuclear fuels.

Division III covers the transformation of primary to secondary energy and transportation of energy. Subdivisions will deal with water power; solid, liquid and gaseous fuels; nuclear, geothermal, and solar energy; and wind power.

Division IV deals with the utilization of primary and secondary energy with subdivisions determined on the basis of broad classes of users.

Division V will be devoted to economic evaluation of alternative energy sources and the coördination of the different forms of energy in various countries.

New Survey Work

The World Power Conference survey of energy resources, to be discussed under Division I, will be released as a new publication prior to the Melbourne meeting. It replaces the former World Power Conference Statistical Year-Book and will be issued at six-year intervals on the occasion of each Plenary Meeting.

Formed in 1924, the World Power Conference, non-government in character, is one of the oldest international technical organizations. Its objectives, as stated in its constitution, are "the development and peaceful use of energy resources to the greatest benefit of all, both nationally and internationally by: (1) considering the potential resources and all the means of production of energy in all their aspects; (2) collecting and publishing data on energy resources and their utilization; and (3) holding conferences of those concerned in any way with surveying, developing or using energy resources." The International Executive Council of the Conference has central offices at 201 Grand Buildings, Trafalgar Square, London, England. Sir Vincent de Ferranti of England is the present chairman of the International Council, which meets annually in various cities of the world to carry on the continuing business of the world-wide organization.

Plenary Meetings of the World Power Conference are held every six years and Sectional Meetings every two years. The date and place of each meeting is determined by the International Executive Council upon receipt of invitations from one or

WORLD POWER CONFERENCE

Francis L. Adams, Head of FPC's Power Bureau and Chairman of the U.S. National Committee for WPC

more of the member countries. The subject of each conference and the details of the program are suggested by the host committee and are subject to approval of the Council. The affairs of the conference are conducted through National Committees established by each of the 59 member nations. Each National Committee includes representatives of industry, government, professional societies, and other interests concerned with the production and use of fuel and power.

U.S. Committee

The U.S. Committee is composed of three groups of participating members. They are (1) professional engineering societies, currently including the American Society of Civil Engineers, the American Institute of Mining, Metallurgical and Petroleum Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Institute of Chemical Engineers; (2) industrial, utility, or similar associations, composed of the Association of Edison Illuminating Companies, Edison Electric Institute, and American Gas Association; and (3) federal and state government bodies, composed of the Atomic Energy Commission, Federal Power Commission, Bureau of Mines and Bureau of Reclamation of the Department of the Interior, the U.S. Army Corps of Engineers, and the Department of Agriculture's Rural Electrification Administration.

The U.S. Committee is managed by an Executive Board of nine members, composed of three members from each of the above named groups. The present national officers are Francis L. Adams, chief, Bureau of Power, Federal Power Commission, chairman; James N. Landis, vice-president, Power Division, Bechtel Corp, vice-chairman; and Brig. General Stewart E. Reimel, U.S.A. (Ret.), secretary. The Secretariat of the Committee is furnished through the Engineers Joint Council, 29 West 39th Street, New York 18, New York. All communications should be directed to the Secretary, U.S. National Committee, World Power Conference, at that address.

The World Power Conference provides a means of bringing together engineers, scientists, economists, administrators and others who are primarily concerned with the development and utilization of the world's energy resources. Through its regular meetings the leaders in technical and economic fields of fuel and power can become better acquainted and pool their knowledge of the world's energy resources.

At a time when United States leadership in technological fields has been challenged, it is particularly important that this country make every effort to demonstrate to the world the competence of its experts in those areas. It is a well-known fact throughout the world that the United States produces over 40 per cent of the world's power supply and that it has led the way in many of the modern improvements and techniques in energy production and utilization. To maintain our position in the eyes of the people of other nations, it is incumbent upon power and energy experts in the United States to assist less developed nations by exchanging information and ideas with them and working coöperatively together to the end that there will be more widespread development and utilization of energy resources by all nations.

An effective way of showing our best face to the world is through active participation in international gatherings such as the World Power Conference. Such participation should include not only the preparation of technical papers but also taking an active part in the work of the conferences by defending our views in open discussions at the technical sessions arranged by the host national committee. Organizations and individuals concerned with power and energy resources, including those in industry, government, professional societies, and educational institutions, are urged to take part in future World Power Conference meetings beginning with the next meeting in Melbourne, Australia, in October 1962.

Plan Ahead!

Membership in a National Committee is not a prerequisite to participation in the technical meetings of the conference, but all participants must register through their National Committees. All interested parties in the United States should write to the United States National Committee for any information desired on plans for participation in the Melbourne meeting.

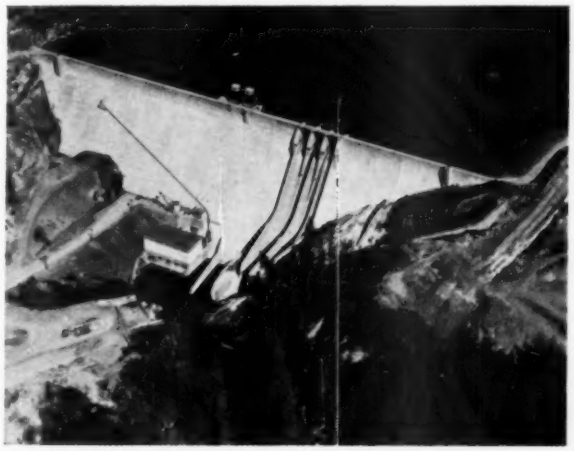
Copies of the technical program for the Melbourne meeting are now available and registration forms can be obtained sometime in 1961 when they are received from the Australian National Committee. THE END

WHITE WATER and CREATIVE POWER

On Baker River in the State of Washington, Stone & Webster Engineering Corporation recently completed the design and construction of a multi-unit project for Puget Sound Power & Light Company. The new Upper Baker Plant will peak at over 100,000 kw, while a new generating unit adds 70,000 kw to the existing Lower Baker Plant.

Full, automatic control of the new plant from Lower Baker, eight miles away is made possible by installation of a microwave and supervisory system. Unique facilities for handling migrant fish include elevators, artificial spawning beds and barges on which mechanical turbulence attracts fingerling salmon for safe passage down through the dam.

Stone & Webster engineers can be counted on to provide the creative touch that makes every new project a true advance in power engineering. We would welcome an opportunity to explain in detail how we can serve you.



STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY OF STONE & WEBSTER, INC.

New York, 90 Broad Street Boston, 49 Federal Street Chicago Houston San Francisco Los Angeles Seattle Toronto Calgary

U.S. STEEL'S RAILWAY MOBILE POWER TRANSFORMER

ROVING POWER UNIT PROVIDES INSURANCE AGAINST SUBSTATION FAILURE

WESTINGHOUSE has produced one of the world's largest mobile transformers ever built — for U.S. Steel Corp. Mr. E. C. Hollingshead, Transformer Design Engineer (in Westinghouse), has furnished technical details of the unit; his comment follows:

This railway mobile transformer is designed for service as an emergency spare for any one of the major power transformers at the various plants of the U.S. Steel Corp. These are located in seven states, from Philadelphia to Chicago, and from Cleveland to Birmingham, Alabama.

Its maximum rating is 60,000 kva at 132,000-volts delta — to 69,000-volts wye, 60 cycles, three phase, FOA cooling. Furthermore, it is rated 20,000 kva, 66,000-volts delta — to 22,000-volt wye 25 cycles. Additional reduced voltage (and kva) ratings are obtained by the use of taps and star delta connections, such as primary voltages of 110,000–66,000–44,000–22,000 and 46,000–23,000–22,000–13,800–13,200–6900–2300 volts in the secondary.

Transformer is mounted on its own railroad car, and the entire assembly has been checked and cleared for shipment to any of the various U.S. Steel Corporation plants. The railroad shipping clearances for a unit of this size are quite restricted. The unit is cleared for emergency movement, not only over the usual freight routes, but for attachment to various passenger trains; also to travel, when so shipped, at unrestricted speeds.

Because of various bridge side-trusses and limitations at plant entrances, truck clearances beneath the car-bed are less than the standard A.A.R. clearances for any standard railway flatcar.

A special railroad car was designed to coördinate with the transformer. The transformer wall braces are welded directly to the car beams. This allows a weight-saving, plus additional strength in the beams, and allows the transformer case to be securely welded to the car.

Use of 6½ by 12-in. Timken roller bearings in each wheel of the six-wheel trucks eliminated the requirement that the car be lubricated according to mileage. This reduces a maintenance problem while the transformer is in storage.

Between periods of use, either as an emergency replacement of a major power transformer or to supply temporary power for construction work, the unit will be stored at a central location which has been selected as a side-track located at the Irwin Works in Dravosburg, Pennsylvania.

As a precaution against breakage, steel mill dust, snow, birds, and small animals, the bushings, lightning-arresters, fan-pumps and tap-changer mechanism are provided with protective covers. Some of these are designed to be useful as supports (and shipping braces) when transporting the transformer.

Items of the Assembly

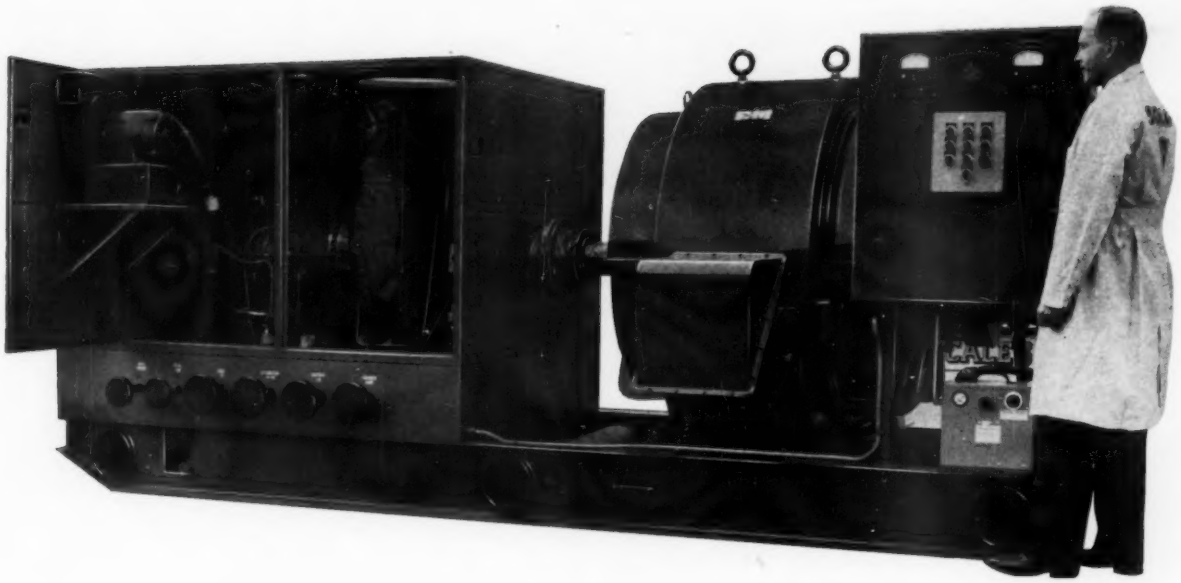
Complete assembly consists of flat-car, transformer, high-and-low voltage bushings, high-voltage lightning arresters, transformer cooling equipment (which is six FA coolers with their individual fans and oil pumps), control cabinet and associated relays for operating the cooling equipment. Also included are the oil storage tank, oil-transfer pump, vacuum pump, and cabinet for the *Inertaire*® system. In addition, some auxiliary transformers and switches, plus a tool and storage box for gasket material, touch-up paint and set of wrenches are provided.

Oil storage tank serves a dual purpose: (1) to hold oil that must be removed to make terminal boards available for changing ratio-connections; and (2) with oil in the main tank, it serves as a gas expansion tank for the "*Inertaire*" system when the transformer is carrying load.

This oil storage tank can be filled by opening a valve in the line connecting it to the main tank. When full, valve is closed, the necessary terminal board changes made, the oil-transfer pump started, and the oil is restored to the main tank. An oil-gauge reading shows the proper level when the transformer is completely filled.

A vacuum pump is available for use in removing trapped air from the transformer after a voltage connection change, or after moving the unit to a new location. Cooling equipment operates on 230 volts, three phase, 60 cycles power, and requires about 20 kva. Any local power source of 460 or 230 volts can be used for cooling; three single-phase transformers, a double-throw switch and a phase-reversing switch will reduce this to the proper operating voltages, and correct polarity, for the correct rotation of the fans and pumps.

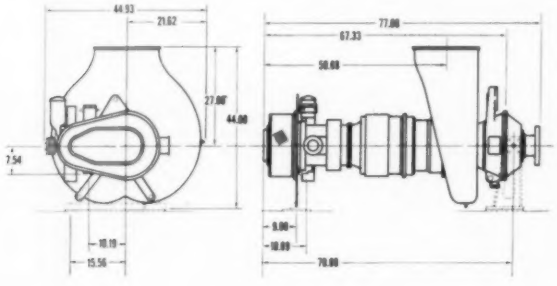
Total weight of this complete transformer assembly is 335,000 pounds; the maximum total weight permitted by the truck bearings is 376,500 pounds. And, by some modification of the Westinghouse standard Form-Fit shell transformer construction, it was possible to design and build this transformer so that it would meet the requirements of the U.S. Steel Corporation. THE END



800 KW!

Solar industrial gas turbine generator sets ideal for peak loading or constant duty

Versatile, compact industrial generator sets powered by Solar's T-1000 gas turbine engine have a nominal rating of 800 kw. They are ideal for either peak loading or constant duty electrical power applications. Simple design and rugged construction reduces maintenance



to a minimum. Installation is extremely simple. The engine is about 1/10th as heavy as diesel units of similar horsepower and occupies only 51 cu ft. No elaborate foundation or flooring base is required because the gas turbine is practically vibration-free.

Equipped with one of the several control systems available, the engine can be operated remotely and entirely automatically. It starts instantly and operates at full load without warmup, even after long periods of standby service.

Fuel economy of the Solar T-1000 engine is unmatched in its field. The engine runs equally well on a variety of fuels including gasoline, diesel fuel and natural gas. The exhaust may be used in a waste heat boiler or as combustion air in process apparatus or conventional boilers.

Cost of this gas turbine is competitive with diesel engines in many industrial applications. For further information on Solar's turbine-powered generator sets, its complete line of gas turbine engines or industrial compressors, write to Dept. H-201, Solar Aircraft Company, San Diego 12, California.

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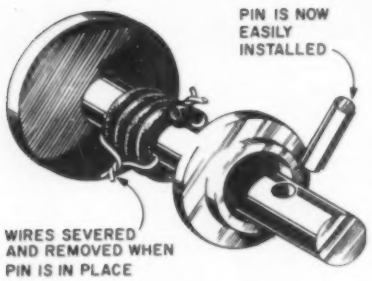


Easy Way to Assemble Precompressed Springs

By GORDON LENAHAN

Natural Gas Pipeline Co

HIGH ON THE LIST of life's little frustrations is the assembly of small thrust springs that seem to be essential in just about every piece of equipment. Most outstanding example is inlet and exhaust valve springs in small gasoline engines. The springs invariably have to be compressed an impossible amount to drop a keeper or pin into place, especially considering the limited working space.

I have solved this problem frequently by putting the spring in a vise with the center flush with the top of the vise jaws. When the spring is compressed, two wires 180 deg apart are installed to hold it compressed during assembly. After the restraining pin is dropped into place, the wires can be nipped and removed.

How to Mount Service Racks in a Tight Place

By M. L. MONSON

Superintendent, Municipal Utilities, Fosston, Minn.

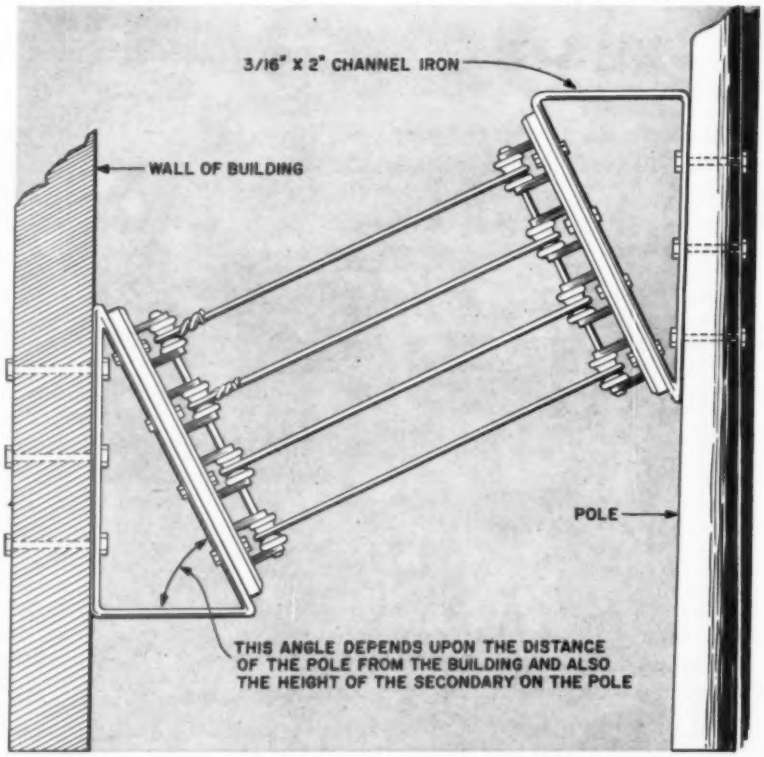
WE HAD A PROBLEM as to method which should be used to run a set of 3-phase 4-wire service to a building which was located very close to the service pole. The angle of the wires on the building was so small that if we had attached the rack directly on the building, the wires would have almost come together.

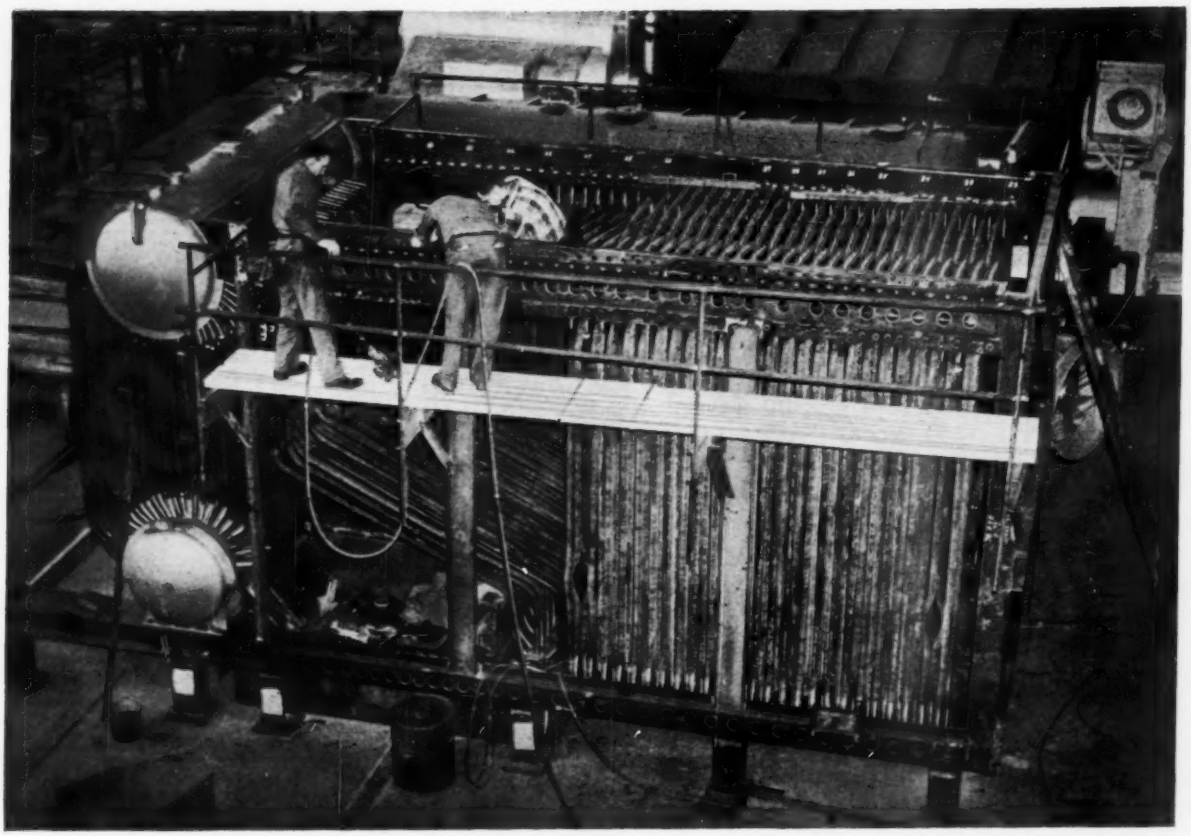
We then devised a method by which the service rack could be mounted at an angle so that the service wires would be kept apart and run parallel. This was done by having an angle iron mounting made as shown in the sketch. The service rack was belted to the channel iron and the channel iron bolted to the wall of the building.

We used this method because we had a service of four No. 500 MCM copper cables, and also there was no room to set the rack in the horizontal position due to a ventilator which was close to the service head.

Distance from the pole to building and also the height of the secondary from the ground on the service pole, and also the height of the service, will govern the angle to use on the rack mounting.

Same type of service rack mounting is used on the pole to keep the wires at a proper distance on the pole.


3/16" X 2" CHANNEL IRON
WALL OF BUILDING
POLE
THIS ANGLE DEPENDS UPON THE DISTANCE OF THE POLE FROM THE BUILDING AND ALSO THE HEIGHT OF THE SECONDARY ON THE POLE



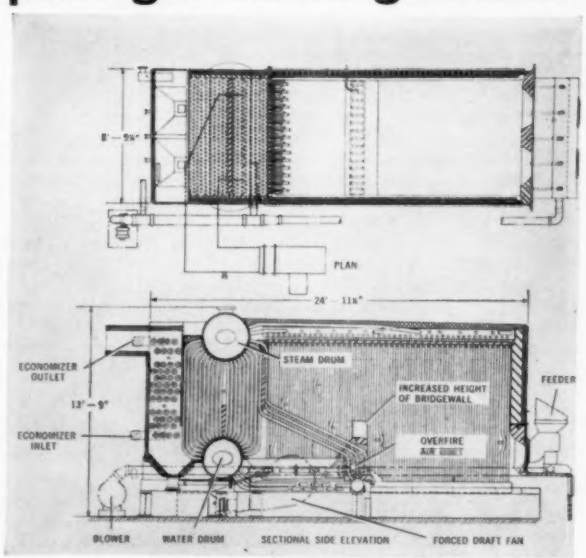
Stoker-fired boiler being shop assembled.

Coal fuels this push-button packaged steam generator

Good news for industry in areas where coal is economical —FW stoker-fired *packaged* steam generators that are comparable with the most advanced gas and oil fired units. Engineered and built with precision, the design has been thoroughly proved and tested in more than two years of operation at full design capacity and above. Performance has been consistently better than expected under all operating conditions.

Units designed for semi-automatic operation are available in three standard sizes: 43,000, 50,000 and 63,000 lb/hr steam capacity at pressures to 250 psig. Push-button control brings these units on or off banked fire. They may be converted to oil firing in a matter of hours. And for easy handling and speedy low-cost erection, they are shipped in three major subassemblies, one of which is the complete boiler and economizer section shown above and at right.

For complete performance and descriptive data on FW stoker-fired packaged steam generators, request bulletin PG59-4. Standard oil and gas fired units are also available in capacities from 13,000 to 100,000 lb/hr. Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.



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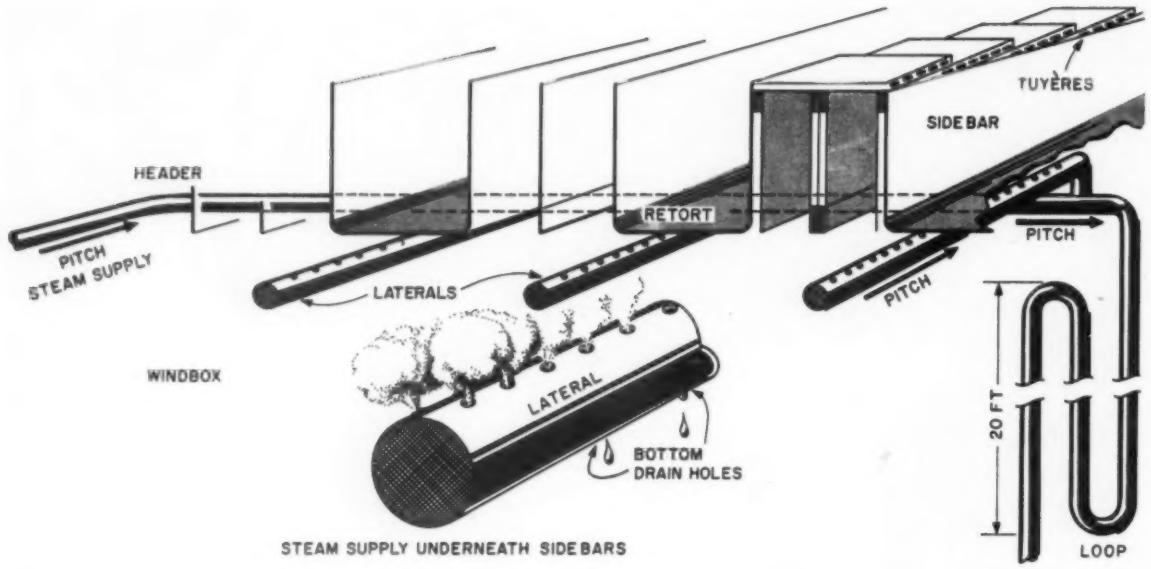

STEAM SUPPLY UNDERNEATH SIDE BARS

How We Use Low-Pressure Steam to Cool Stoker Grates

By HERMAN A. LUDEWIG, Principal Sta. Engineer, Green Haven State Prison, Stormville, N. Y.

WHERE GRATES in an underfeed stoker are not watercooled and their rate of loss is a problem, low-pressure steam in the windbox may be used as a cooling medium. For many years we have used the conveniently located exhaust line from the stoker-engines for this purpose. The exhaust line is tapped, 1½-in. or 2-in. pipe, and valved. It is also connected to a header located in the back of the windbox, in front of the seal plates. The header traverses the full width of the windbox, then turns down, exits through the bottom of the windbox and ends in a loop.

The loop must be high enough to hold back the maximum back-pressure carried. In our plant, it discharges into the sewer at a lower floor. The whole piping has a progressive pitch towards the loop.

From this header, directly under the tuyères, as shown in the sketch, laterals are taken and led up and forward towards the boiler front. Their ends are sealed — ¾-in. to 1-in. pipe or tubing is sufficiently large for a tuyère length of 72 ft — and are easily suspended from existing I-beams. The tops of these laterals are drilled, ⅛-in. diam, ½-in. apart, for their full length, permitting steam discharge into the bottoms of the grate supports.

The orifice sizes may be more moderate than stated, on the laterals near the supply of steam, and may be made progressively larger in diameter as the point of exit is approached. This is to compensate for pressure drop and increase in moisture content.

This scheme has had a most salutary effect on our grate consumption and pin breakage. However, there are some drawbacks — first, the consumption of steam, and second, heat loss, as the steam must be raised in temperature to that of the flue gases. Of lesser importance is the presence of dampness in the windbox which, if constructed of steelplate, requires a coat of asphalt base paint every two or three years.

The moisture and oil film deposited by the engine exhaust has a tendency to bind very fine coal dust. This accumulates on top of the laterals and should be removed weekly. At this time (and this would be a good thing anyway) the tuyère bottoms can be cleaned of any accumulation of deposits, to keep the air passages clear. This operation may be performed with a long piece of ½-in. tubing with a 90-degree bend on one end, without entering the windbox.

All in all, we think that the merits of this scheme far outweigh the demerits. The whole stoker operation seems to be eased up. It seems that the latent heat of vaporization of the moisture in the windbox, and as deposited on the sidebars and tuyères, does, as it should, exert a beneficial cooling effect on these metal parts, where most needed.

Temperature of the air in the windbox, comparatively high due to the steam, partly offsets the loss due to the steam in the flue gas. A heavier firebed is possible, as the steam passage through the fuel bed makes the latter more porous, and a heavier bed is more likely to protect the grates. A better CO_2 is more than likely as a side-benefit.

SHARING ON-THE-JOB EXPERIENCE . . . is the purpose of this practical Handbook. We welcome your letters and descriptions telling us of practices and devices that have helped you turn in a more efficient performance. What has helped you will help others. So let us hear from you. For contributions like these we pay up to $35. Try to include rough sketches and/or photographs.

Power Engineering HANDBOOK

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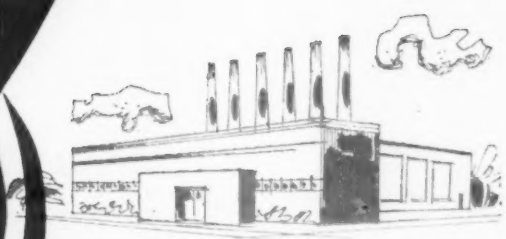
With Valley Camp Special Spreader Stoker Coal



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New Engineering Books

National Electrical Code Handbook: Based on the 1959 Edition of The National Electrical Code. Revised by Frank Stetka, Electrical Field Service Engineer, National Fire Protection Association. Tenth Edition, 680 pages, 5¾ x 8 in.: 387 illustrations, 53 tables. Published by McGraw-Hill Book Co, Inc, 330 W. 42nd St, New York 36, N. Y. Price $10.

Facts on how to handle all types of electrical wiring and installation jobs in strict accordance with the latest National Electrical Code are presented in this newly published edition of a well-known handbook. It explains rules and measurements for electrical jobs — what they mean and how to apply them. The book follows exactly the same numbering system as presented in the code, providing easy reference to any rule. Next to the rule, in contrasting typeface, is found its meaning, intent and interpretation where applicable.

This edition was prepared under the supervision of the National Fire Protection Association. Important new features include reorganization in line with the rearrangement and renumbering of the National Electrical Code. Modern examples are given of how to calculate electrical load, number of branch circuits, and size of feeders.

★ ★ ★

The Arc Discharge (Its application to power control), by H. de B. Knight; 444 pages, 5½ x 8¾ in. Published by Chapman & Hall Ltd, 37 Essex St W.C. 2, London, England. Price $9 (63 s.).

This book is concerned with the use of arc-discharge tubes such as thyratrons, ignitrons, and excitrons for the control of electrical power. It describes the construction and operating characteristics of the different types available, their capabilities and limitations, the conditions they need for satisfactory service, and their behavior in miscellaneous rectification and control circuits. Physical processes involved inside the tubes are also discussed.

There is much of interest for the electronic tube designer and manufacturer as well as for the student, the application engineer, and any user of arc-discharge control devices. The book is fully illustrated and contains a thorough index and bibliographies. This comprehensive survey will be valuable both as a primer and book of reference.

★ ★ ★

Transistor Manual; 329 pages, 5½ by 8½ in., spiral bound, paper cover. Edited and published by Semiconductor Products Department, General Electric Company, Charles Building, Liverpool, N. Y. Price $1.

This handy reference on transistors and application principles is now available in a new fifth edition. Four new chapters have been added to include Tunnel Diode Theory and Switching Circuits, Tunnel Diode Amplifiers, Feedback and Servo Amplifiers, and Test Circuits.

Chapters on Silicon-Controlled Rectifiers, Power Supplies, Transistor Specifications, and Rectifier Specifications are expanded and revised. The Transistor Specifications chapter contains a current listing of American JEDEC-registered transistor types with specifications and interchangeability information.

Copies of the manual may be obtained from G-E distributors or by writing to the Semiconductor Products Department, General Electric Co, Kelley Building, Liverpool, New York.

★ ★ ★

Creative Engineering Design, by Harold R. Buhl; 195 pages, 6¾ by 9¼ in., illustrated, cloth binding. Published by the Iowa State University Press, Ames, Iowa. Price $3.95.

Many alert engineers desire to get off the beaten path — to think imaginatively and design creatively. Sometimes obstacles to greater creativity are psychological factors within the person himself, or his environment, or habitual methods of perception and thought. To overcome these obstacles requires first an awareness, and then serious effort to apply the very usable principles of creative design to everyday work.

This book will help to bring all this into focus in a very practical and stimulating way. Its style is non-technical and conversational, with humorous drawings. Liberal use of sample problems is a help.

Harold R. Buhl is a member of the Mechanical Engineering Dept of Iowa State University, and his present book was selected by Iowa State University Press as the "most significant new book by an Iowa State faculty member" in 1960.

★ ★ ★

Treated Wood for Marine Use, ASTM Special Technical Publication No. 275; 69 pages, 6 by 9¼ in., cloth bound. Published by the American Society for Testing Materials, 1916 Race St, Philadelphia 3, Penna. Price, $2.50; to members, $2.

This symposium of seven papers was presented at ASTM's third Pacific area national meeting in 1959. Subjects covered are: Use of small panels in screening potential wood preservatives; standard toxicity valuation of chemicals poisonous to the marine borer; column chromatography in the analysis of creosote; evaluation of wood piles in sea water by standard rating system; extending service life of wood piles in sea water; determining preservative retention in piling by assay of borings; marine exposure tests of pressure-treated Douglas fir and Southern pine.

Lighting Handbook, by Westinghouse Lamp Div, revised edition; 250 pages, 5¼ by 7½ in.; wire-o/leatherette binding which permits pages to lie flat when book is open. Published by Westinghouse Electric Corp, Bloomfield, N. J. Price $3.

This revision of a well-known and handy reference contains a comprehensive coverage of the general field of modern lighting practices. Included is a fold-out page in full color of the electromagnetic spectrum, information on distribution and light measurements, a section on the newest light sources, information and coefficients of utilization and maintenance factors, together with footcandle tables, and many application illustrations.

Major changes have been made in the chapters on floodlighting design, roadway lighting and sign lighting. Also, the most recent recommendations of the Illuminating Engineering Society for commercial and industrial interiors are included.

★ ★ ★

Resistance Welding Control-IC-2-1960; 94 pages, 8½ by 11 in., mimeographed, unbound. Published by the National Electrical Manufacturers Assn, 155 E. 44th St, New York 17, N. Y. Price $1.

Developed by NEMA's Industrial Control Section, this new standard includes definitions and cycle diagrams for all generally used resistance welding processes. Definitions and diagrams are cross-referenced with a master table listing NEMA identification numbers for the control equipment required to perform each of the described functions.

Also listed are minimum standards for such factors as accuracy, time range, size and capacity, which are widely used in the industry. Separate sections are included for frequency converter controls, gun welder controls and multi-function process timers.

★ ★ ★

Ingenious Mathematical Problems and Methods, by L. A. Graham; 237 pages, 5⅜ by 8 in.; paper cover. Published by Dover Publications, Inc, 180 Varick St, New York 14, N. Y. Price $1.45.

This is a new kind of puzzle book featuring original contributions by outstanding engineers and mathematicians. It is a collection of problems from a column which appears in the Graham *Dial*, organ of Graham Transmissions, Inc.

Mr. Graham has chosen problems which call for some knowledge of all branches of mathematics. A few require more alertness of thought than mathematical training.

Some problems demand the application of rather advanced mathematics. However, most can be solved effectively by a number of methods. It is pointed out that no solution is definitive, and there is always room for more experimentation and improvement.

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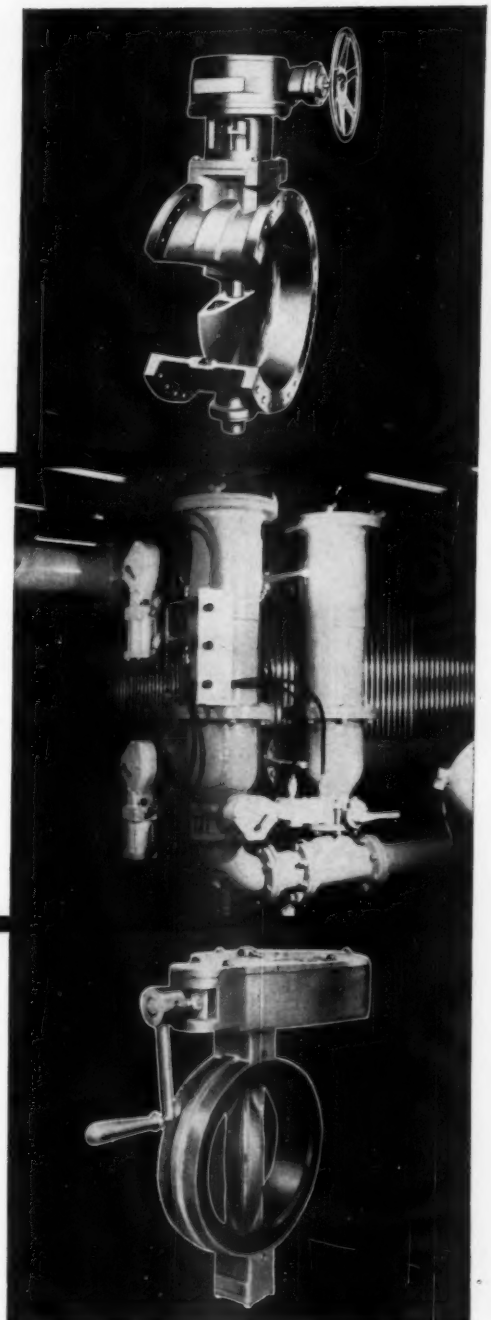

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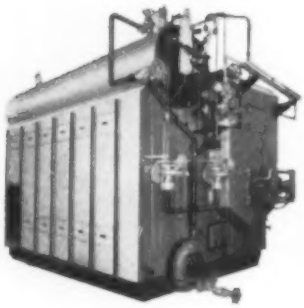

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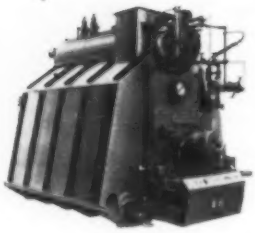

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Commercial Literature

Power Engineering

Reviewed here are the editors' choice of manufacturers' catalogs now available . . . selected on the basis of information helpful to power engineers. Use the Reader Service Cards to order free copies of those you would like to have in your own files

Pumps and Compressors

201 Vertical Turbine Pump — Featured by Worthington Corp. in 16-pp Bulletin 2400-B1 are ultra high flow vertical turbine pumps. Design improvements, which result in broader coverage and higher efficiencies over wider operating ranges, are illustrated and described.

202 Submersible Sump Pump — Eight-pp Bulletin 5300, The Deming Co., describes features and operation of a submersible sump pump which can be lowered into a pit for temporary service or permanently installed for continuous service.

203 Handbook on Pumps — Engineering Manual EM-611, issued by Marlow Pumps, Div., Bell & Gossett Co., contains 42 pp of comprehensive data on pumps and pumping. Defines common pump terms, and includes friction loss data, capacity and volume equivalents, decimal equivalents, horsepower requirements, installation details, viscosity and specific gravity table.

204 Rotary Vacuum Pumps — Features of Consolidated Vacuum Corp's oil sealed rotary vacuum pumps are detailed in 6-pp Bulletin 8-15. Discusses building block construction, ease of maintenance of these pumps, includes selection suggestions. Dimensions, physical specifications and speeds and capacities given.

205 Pump Selection Catalog — Included in 12-pp easy-to-use Circular 184 of Dean Brothers Pumps Inc. are charts showing recommended temperature and pressure ranges for 10 classifications of company's pumps — from −350 to +1000 F, and up to 1000 psig. Illustrations, descriptions and specifications are shown.

206 Rotary Air Pumps — Catalog 460, 32 pp, of Leiman Bros., Inc., describes rotary positive air pressure and high vacuum pumps, gas boosters and air motors. Gives construction details, dimensions, capacities, performance curves for all pumps, plus comprehensive engineering and application data.

207 Free-Piston Pumps — Features and advantages of an air-operated free-piston pump designed to pump anything that flows are detailed by The Crossley Machine Co. in this product bulletin. Sequence diagrams show operation.

208 Power Plant Pumps — Bulletin BJP-588, Byron Jackson Pumps, Inc., describes standard pumps for all power plant requirements — from 12,000 hp, double-case boiler feed pump, to condensate, circulating and booster pumping duty. Also describes special pumps for nuclear power plant installation.

209 Sizing Cooling Tower Pumps — Six steps to be taken in sizing pump and piping of any cooling tower installation are explained by Bell & Gossett Co. in 6-pp Bulletin CT-360. Provides selection charts, pipe sizing tables.

210 Pumps and Controls — Bulletin 220 contains 72 pp of data on design details and operating characteristics of hydraulic pumps, fluid motors and valves offered by Dennison Engineering Div., American Brake Shoe Co. Sections are devoted to types of hydraulic pumps, pumping units, fluid motors, and control valves, covering design and operating characteristics of components.

211 For Abusive Pumping Jobs — Catalog 5206, Nagle Pumps, covers centrifugal pumps adapted to handling ashes, abrasive mixtures, slurries, hot and corrosive liquids. It describes several basic types: a horizontal shaft, single-stage side suction pump; a horizontal shaft, single-stage, rear-entrance automatic priming pump; vertical shaft pumps with standard, overhead and quill bearings for wet pit applications.

212 Pumping and Hydraulic Data — Definitions, formulae, testing, tables, charts and definitions useful in pumping and hydraulics are covered in 20-pp Bulletin EM-77 issued by Peerless Pump Div., Food Machinery and Chemical Corp. Includes facts on how to figure NPSH, pump efficiency, mechanical and electrical equivalents, and pipe friction loss chart.

213 Simplified Pump Selection — Technical data is simplified and presented

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in an easily-understood way in the Deming Co.'s rotary pump selection manual. Groups liquids according to viscosity and each classification has its own selection table. Fast selection is possible by matching liquid to pump.

214 Air Compressors — Design and construction details on Joy Mfg. Co.'s semi-radial air compressors are presented in 24-pp Bulletin A-72. Illustrates semi-radial construction which results in better balance, less weight, and quick installation, and includes specification data.

215 Compressed Air Fundamentals — Sixteen-pp Form 1548, Ingersoll-Rand Co., is intended to aid in selection of a small "packaged" air compressor. Discusses compressed air, how it is compressed, single- and two-stage compressors, piston displacement, control used etc. Includes information on compressor oils, pipe sizes, wire sizes, terminology.

216 On Eliminating Explosions — In 12-pp Bulletin 173, Clark Bros Co., presents recent findings on mechanism of explosions in pipelines and compressor starting air lines. Discusses research on nature of explosions and shock waves in piping, and these observations are applied to compressor air starting systems.

217 Liquid Pulse Traps — Bulletin 201A describes Pulsation Controls Corp.'s liquid pulse traps for all types of reciprocating, rotary pumps and hydraulic systems. Construction details, performance curve, and selection data included.

Packings, Seals, Gaskets

218 Packing Chart — This packing recommendation chart by Raybestos-Manhattan, Inc., shows basic packing types for 95 per cent of all packing needs. Covers such applications as: pumps and valves, high-temperature valve stem and expansion joints, high-speed rotary air compressors, corrosive and viscous liquids, chemicals, gasket applications, and hydraulic and pneumatic equipment.

219 Corrosion Resistance Chart — Over 150 chemicals and their recommended usage with ductile iron, iron, steel 316 and 304 stainless steel, Monel, brass, bronze, copper, aluminum and plastisol plastic are listed in Corrosion Resistance Chart J-CRC. Prepared by OPW-Jordan Corp., chart shows which gasket materials are needed when Kamlok couplers are used and which O-ring materials are needed when swivel joints are used.

220 On Boiler Gasket Leakage — Some causes of boiler gasket leakage are discussed in Technical Paper 139 by Betz Laboratories, Inc. Factors to consider in overcoming or minimizing gasket leakage, such as selection of gasket joint, installation, and corrosion protection, are explained in detail.

221 O-Ring Handbook — Catalog 5711 is a 24-pp design and data book of Parker Seal Co. on Viton O-rings. Contains test information on some 150 fluids and gases to which this synthetic elastomer is compatible; recommended design techniques; general information on three compounds; data on all standard sizes.

222 Mechanical Packing Guide — Johns-Manville's 64-pp catalog, Form PK-131A, contains comprehensive information on mechanical packings. Includes chemical selection chart listing more than 700 liquids common to process industries. Also featured is a simplified selection chart to help relate operating conditions to most suitable packing.

223 Mechanical Packings — Catalog P-210C, Raybestos-Manhattan, Inc. contains 40-pp of detailed information on mechanical packings and gasket materials. It contains illustrations, descriptions, complete service recommendations and specification charts.

Piping, Valves and Fittings

224 Valve Selection Tips — In addition to cross indexing company's own line of valves with those of other manufacturers, The Ohio Injector Co.'s Valve Buyer's Guide, 22 pp, contains a list of frequently used abbreviations, a valve trim chart, other data. A breakdown by valve material and pressure class, and classification by type, disc design, etc., aids in selection.

225 To Stop Water Waste — Bulletin 553-A of Leslie Co. points out ways that proper valve selection and application can reduce "hidden costs" connected with the use of water in industry. Describes how water reducing valves operate and gives information on sizing.

226 Valve Selection Data — Facts to keep in mind when selecting a valve for a specific application are detailed in Crane Co.'s 20-pp Bulletin AD-2016. Three principal valve types are illustrated and described, and cutaway views showing component features included.

These catalogs can be yours without cost or obligation. Use the Reader Service Cards to indicate your choice—just circle the item numbers of those you want.

227 Silent Check Valves — Described by The Williams Gauge Co., Inc. in Bulletin WH-654 are silent check valves featuring low frictional resistance. Tables list dimensional data and reasonable velocities for flow of water through pipe, fitting, and valves.

228 Check Valves — Details and specifications on check valves designed to eliminate water hammer and line surge are presented by Combination Pump Valve Co., in 20-pp Catalog 600. Typical installations are illustrated, and installation data, flow chart, and ratings included.

229 Valve Materials Calculator — Preferred valve materials for different types of corrosives are shown in this calculator prepared by Hoke, Inc. It is designed as a guide to the selection of materials of valve construction, based on "substantial," "moderate," "questionable" or "inadequate" resistance to chemical in question at atmospheric pressure temperature.

230 Bronze Gate Valves — Presented by The Wm. Powell Co. in Form 198, is a line of bronze union bonnet gate valves for 125 to 150 WSP. Features are shown on cutaway view, and dimension given in tables.

231 Stock Solenoid Valves — Solenoid valves available "off the shelf" from Automatic Switch Co. are presented in 16-pp Stock List and Selection Guide 506. Contains engineering information, simple selection data, illustrations and flow diagram of two-, three- and four-way types, manual reset valves, special purpose valves.

232 Specifying Solenoid Valves — Included in Valcor Engineering Corp.'s 8-pp booklet on specifying solenoid valves are a description of various types of valve sealing; a discussion of mechanical specification criteria including application description, fluid characteristics, pressure, capacity, leakage, valve life.

233 Control Valves — Steam and liquid control valves manufactured by O. C. Keckley Co. are illustrated and described in 56-pp Catalog 58-A. Covers strainers, pressure regulators, temperature regulators, safety and relief valves, pressure reducing valves, diaphragm control valves, solenoid valves, float valves, others. Includes capacity tables, specifications, cutaway views.

234 Relief Valves — Bulletin V-100/60, 24-pp, describes J. E. Lonergan Co.'s line of bellows valves for vapor service. It gives complete details and specifications on sizes, capacities, materials and other pertinent data. The seven exclusive features of this valve are also listed.

235 Safety-Relief Valves — Liquid relief and special service safety-relief valves, including a new, low cost compact series, are presented by Farris Engineering Corp. in 28-pp Catalog FE-138. Valves shown include types for hydraulic pressure systems, liquefied gases, chemical corrosive service and general industrial service.

236 Boiler Blow Off Valves — Bulletin E-125, 24 pp, describes and illustrates the design and construction of Everlasting Valve Co.'s quick-operating valves, angle valves, Y valves and duplex units specifically designed for boiler blow-off service. Includes dimensions.

237 Solder Joint Valves — This circular of Walworth Co. lists size and

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dimensions of bronze gate, globe and check solder joint valves including the new No. 2 SJ gate valve. Each type is illustrated with a cutaway picture showing path of fluids through valve body. Shows how to make a sound solder joint.

238 Guide to Strainers — Presented by Tate Engineering, Inc. in this 88-pp handbook are reference data for layout of fluid flow systems and sizing of strainers, tabulated results of testing, and valve and pipe selection information. Reference material for each strainer section is on a fold-out page for use with any specific page in that section. Book contains over 100 illustrations of pressure drop, temperature, and viscosity charts, also engineering drawings.

239 Supports for Piping — Described in 96-pp Catalog 59, is a system utilizing pre-engineered standard components in almost infinite combinations to solve most piping and equipment support problems. The system, introduced by Bergen Pipesupport Corp., affords savings in engineering and field costs, offers simplicity of use. Book also gives details on constant support hangers; roller devices; variable supports, light duty and cushion-spring hangers.

240 Materials for Main Steam Piping — Entitled "The Plastic Ductility of Austentic Piping Containing Welded Joints At 1200 F," this 16-pp bulletin of Pittsburgh Piping and Equipment Co. deals with an investigation into the problem of selection of materials for main steam piping. Gives stress rupture characteristics of Type 316 and 347 stainless steel piping adjacent to welded joints.

241 Power Piping Erection — Field erection of high-temperature, high-pressure power piping is the topic of this 12-pp bulletin released by The M. W. Kellogg Co. Illustrated with photos and diagrams, it shows how detailed plans are developed, field-erection costs and quality controlled.

242 Pipe Thread Fittings — Advantages of pipe thread fittings designed to eliminate positioning problems, leakage, and overtightening damage are detailed by the Tru-Seal Div. of Flick-Reedy Corp. in this product bulletin. Common types of positioning, distortion, alignment, reworking and leakage problems and their solutions are illustrated.

243 Plastic Pipe, Fittings — PVC pipe, valves and fittings and their uses are covered in this 36-pp handbook by Kraloy Plastic Pipe Co., Inc. Specification, design and installation data are included, as well as a comprehensive corrosion resistance comparison chart of seven types of plastic pipe carrying 162 chemicals.

244 Good Piping Charted — Recommended piping practices are presented in this wall chart form by The Lunkenheimer Co. Chart is divided into five sections covering basic valve types, connections normally used, installation and maintenance tools, installation, operation and maintenance.

245 Pipe Alignment Guide — This bulletin of The Align-O-Pipe Guide Co. introduces a device for guiding pipe lines which are expanding or contracting because of temperature changes. Explains how units permit movement of pipe line in an axial direction only.

Ventilating, Refrigeration and Air Conditioning

246 Industrial Fans — Fundamental data on industrial fans incorporating a universal discharge are presented by Lehigh Fan & Blower Div. of Fuller Co. in 28-pp Bulletin L-5. Included are rating tables giving volumes of air delivered, rpm, horsepower at various static pressures, and outlet velocity and velocity pressures, as well as tables of correction ratios.

247 Centrifugal Fans — Catalog 1120–1 of Westinghouse Electric Corp. contains 76 pp of detailed information on all-purpose centrifugal fans with flat, backwardly inclined blading, suited for supply and exhaust, general building ventilation, industrial air conditioning and processes. Key components and features illustrated, performance data tabulated.

248 Air Engineering — Bulletin E-57, is a 24-pp air engineering data file, offered by Aerovent Fan Co., Inc. Covers engineering and test facilities for propeller fans, specifications, construction, maintenance, and installation. Tables for estimating air-handling requirements, entrance and elbow losses provided.

249 For Controlled Ventilation — This 20-pp catalog of The Loren Cook Co. is designed as a guide in determining exact type ventilation equipment for specific needs. Guide matches design features with ventilation requirements and special conditions, controlling efficiency, and economy and lengthening life of unit.

250 Plastic Ventilating Equipment — Illustrated and described in 18-pp Bulletin B-500 are plastic ventilation products of Heil Process Equipment Corp. including ventilating ducts, fittings, exhaust hoods, stacks, covers, fans, and fume scrubbers. Physical and chemical properties of glass-reinforced plastics given.

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251 Conditioner Units — Design features of Climate Makers, based on the building block principle, are detailed by Airfan Engineering Co. in 60-pp Catalog AHV-59. Gives fan capacities, direct expansion cooling capacities, and coil data, chilled water cooling capacities, chilled water coil data, mean effective temperature, psychometric data.

252 Cold Room Conditioning — In Bulletin 95, Niagara Blower Co. describes the No-Frost method of producing temperatures down to −90 F for freezing, testing, cold storage etc., giving advantages. Operation with two-stage and three-stage cooler discussed.

253 Packaged Air Conditioners — Performance characteristics and engineering features are detailed in color-illustrated Bulletin 8825, 12-pp, from American-Standard Industrial Div. Typical installation photos showing units with and without discharge plenum are included to illustrate a discussion of owner advantages.

254 Refrigeration Condensers — Engineering data on refrigeration condensers are featured by Henry Vogt Machine Co. in 38-pp Bulletin RC-2. Ratings in tons refrigeration are tabulated for large and small ammonia condensers, vertical ammonia condensers, freon condensers, condenser-towers.

255 Coil Selection Guide — Information on Young Radiator Co.'s water and direct expansion refrigerant coils is given in 28-pp Catalog 5559. Provides selection data on water heating and cooling coils; physical and performance charts; mean effective temperature difference charts. Also includes capacity tables, psychrometric chart, total heat table, dimensions, piping diagrams.

256 Refrigerated Purging Guide — In 12-pp Bulletin 700, Armstrong Machine Works gives helpful data on automatic removal of air from refrigeration systems. Tells why purging is necessary, how noncondensable gases affect efficiency, methods of purging, where to make purge connections and how to use the purger.

257 Air-Cooled Condensers — Four types of air-cooled condenser units are discussed by Halstead & Mitchell in 12-pp Bulletin AC-102 — those using propeller fans for horizontal air flow, propeller fans for vertical air flow, centrifugal fans for use with ductwork, and centrifugal fans.

258 Air Conditioning Units — Detailed information on a packaged central

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station air conditioning unit designed by American Air Filter Co., Inc. to give exact type and degree of air cleaning is presented in 60-pp Bulletin AC-100. Component features are illustrated, and selection data including psychrometric calculations, size selection, arrangement and location, air volume and velocity data, air resistance data given.

Insulation, Refractories

259 Thermal Insulation — Described in 54-pp Catalog IN-244A are Johns-Manville thermal insulations for all types of commercial and industrial requirements from —400 to 3000 F. Contains six sections, each devoted to a specialized group of insulations, including industrial and high temperature; plumbing, heating and air conditioning; refrigeration; insulating firebrick and refractories.

260 Insulation Specifications — In this set of six specifications, Pittsburgh Corning Corp. covers applications of Foamglas insulation for industrial equipment and piping. Each booklet contains tables of suggested thicknesses of insulation to be applied, drawings of insulation procedure, supports and recommended finishes. Booklets are devoted to low-, medium-, high-, and dual-temperature equipment, to underground piping, and spheres.

261 Insulating Materials — Properties and specifications of over 30 insulations for service from sub-zero to 1900 F are presented in this 24-pp 1960 catalog of Baldwin-Ehret-Hill, Inc. Spun mineral wool, calcium silicate, and 85 per cent magnesia products in block, blanket, felt, fill cement, and pipe insulation are described. Thermal conductivities and tables of recommended thicknesses are given.

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262 Insulation Specifications — Johns-Manville's 50-pp manual of specifications, IN-128A, is designed for power, chemical and petroleum industries. It is divided into five sections — insulations for temperatures above 100 F; those for temperatures below 100 F; tank insulation; sphere and spheroid insulation; regenerator, catalytic reactor and oil heater lining and insulation. Tables include recommended thicknesses for both steam generating plants and process equipment.

263 Thermal Insulation — This 16-pp bulletin released by National Insulation Manufacturers Association is designed to serve as a guide to best use of thermal insulating materials under changing conditions of modern industry. Emphasizes "economic thickness" approach to specification, which enables determining point at which insulation gives greatest financial return for its cost.

264 For Insulation Protection — Comprehensive data on mastics, coatings, adhesives, and flashing compounds for thermal insulation has been classified as to industry usage — power, process, cold storage, marine and commercial — in this ready-reference loose-leaf manual, about 208-pp, of Benjamin Foster Co. Detailed application information and product data included.

265 Pipe-Fitting Insulation — Design features and advantages of an improved molded Fiberglas pipe fitting insulation are detailed by Fibrous Glass Products, Inc. in Bulletin TD-105. Specifications included.

266 Underground Piping Insulation — Advantages and characteristics of a granular insulation for underground steam lines, are detailed by Insul-Fil Co., Inc. in eight data sheets. Application details are illustrated and described.

267 Refractory Mortar — This is a 24-pp manual covering the use of Lumnite calcium-aluminate cement as a mortar mix for gun-applied linings in power plant refinery and metalworking equipment offered by Universal Atlas Cement Div., United States Steel Corp. Includes data on mortar preparation, placing procedures.

Steam Boilers, Heat Exchangers

268 Automatic Boiler — Application of the Coal-Pak automatic package boiler to low-pressure steam heating, hot water heating, and high-pressure process steam is covered by Bituminous Coal Institute in 36-pp Guide Specifications GS-3. Sample specifications included, coal and ash handling, wiring, and boiler room layouts.

269 Hot Water Boilers — Twenty-pp Brochure HCC-2 of Combustion Engineering Co., Inc. describes and illustrates design, construction, advantages and economics of the C-E La Mont controlled circulation hot water boiler. The unit is for supplying high pressure, high temperature water for heating and process uses.

270 Packaged Steam Generator — The performance story of a prototype stoker-fired packaged steam generator in one typical installation is told by Foster-Wheeler Corp. in 8 pp Bulletin PG-59-4. An evaluation of performance is presented.

271 Packaged Boilers — A complete discussion of firetube boilers — from construction features to final test and start-up service — is presented in 12-pp Bulletin Form AD-178, Cleaver-Brooks Co. Full-color cutaway features of packaged boilers through 600 hp for heating and processing, steam or hot water.

272 Packaged Boiler — Features and advantages of a completely packaged fire-tube boiler, Type CF, for capacities from 400 to 600 bhp are detailed by Superior Combustion Industries, Inc., in this product bulletin. Cutaway view showing component features is included.

273 Package Boilers — This 12-pp booklet on package steam generators describes the formulas behind all package steam generators. Published by Crane Co.'s Cyclotherm Div., it tells how installation of a package steam generator can raise steam capacity in an existing boiler room.

274 Heat Exchangers — Shell and tube heat exchangers, including copper base allow, steel and stainless steel fixed tube bundle heat exchangers, are described by The Young Radiator Co. in 16-pp Catalog 1258A. Includes pressure ratings and material specifications for steam service heat exchangers, selection data, oil viscosity graph.

275 Heat Exchangers — Engineering Manual PB-EM 102-A, The Carbone Co., contains 22 pp of illustrations, cutaways, diagrams and design data on Polybloc impervious graphite heat exchangers, corrosion-resistant, high thermal conductivity units. Provides charts, graphs, typical calculations.

276 Heat Transfer Equipment — Design and construction features of heat transfer equipment are detailed in 20-pp Bulletin HE-8 of Henry Vogt Machine Co. Covers the positive seal baffle, film type heat exchangers, waste heat boilers, high pressure and high temperature heat exchangers, exchangers of special alloys.

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Electrical Equipment

277 Synchronous Motors — Advantages of The Ideal Electric & Mfg. Co.'s high speed synchronous motors are detailed in 12-pp Bulletin 501. Cutaway view illustrates component parts and details of maintenance and operation.

278 Shielded A-C Motors — Comprehensive 56-pp Catalog 200, Sterling Electric Motors, Inc., includes complete dimensional, selection and application data on Multi-Shielded a-c motors. Includes information for various modifications, such as specialized mountings.

279 FHP Motors — Twelve-pp Bulletin GEA-6424A discusses features and advantages of General Electric Co.'s fractional horsepower, Form G, general purpose motors, including capacitor-start, split-phase, permanent-split capacitor, shaded-pole and polyphase motors.

280 Submersible Pump Motors — Eight-pp Bulletin F-2000, U. S. Electrical Motors Inc. contains full-length cutaway drawings showing construction details, features of submersible motors for 6-, 10- and 14-in. well diameters and explains their water-filled operating principle.

281 Induction Motor Selector — Selection, application and buying information on General Electric Co's Tri-Clad '55 motors, single- and three-phase, from ¾ to 150 hp is given in 14-pp Bulletin GEC-1049. Includes chart for various loads and ambient conditions, tables for dimensions, prices, characteristics and performance data, ordering instructions, modifications, and accessories.

282 Pump Motors — This 34-pp brochure of U. S. Electrical Motors Inc. consists of a collection of technical articles on pump motors, illustrated with charts, diagrams, graphs, tables, and cutaways. Subjects range from turbine pump motor lubricants, pump motor bearings, to pumping stations and sound control, and steps in submersible installations.

283 Motor Selection Guide — This pocket-size card (GED-3909A) provides quick reference to frame size (182 to 445U) and book price for General Electric Co.'s a-c motors from ¾ to 125 hp. Data are tabulated for both drip-proof and totally enclosed fan-cooled Tri-Clad '55 squirrel cage, horizontal motors.

284 Motor Application Guide — Sixteen-pp Bulletin 270B outlines characteristics of Century Electric Co. motors of 1/20 to 400 hp and includes up-to-date design information on them. Discusses factors in motor selection and provides illustrated charts covering a wide range of motor-using equipment.

285 Wire and Cable Data — These composite, color-coded data sheets contain information formerly found only in many catalogs on wires, cables and power cords. Prepared by Continental Copper & Steel Industries, Inc., data sheets give prices, stranding, strand diameters, temperature ratings, weights, overall diameters.

286 Portable Cords, Cables — Specifications and characteristics of various portable cords and cables are presented in this 52-pp booklet of Kaiser Aluminum & Chemical Sales, Inc. Gives pertinent data on insulation and jacket compounds, and includes tables giving properties of 600-v portable cables, also 601-5000-v portable cables, and others. A section is devoted to splicing and patching.

287 Cable Splicing Fundamentals — Illustrated with step-by-step photos, this 30-pp booklet of The Okonite Co. explains procedure for splicing and terminating rubber-Neoprene cables, shielded and unshielded. Also includes tape selector and quantity estimating charts.

288 Rigid PVC Conduit — Applications of rigid polyvinyl chloride in the electrical field are detailed in this 20-pp bulletin released by Kraloy Plastic Pipe Co., Inc. Included are comprehensive test results, specifications, installation instructions, corrosion-resistance charts.

289 Why Plastic Conduit — Advantages of using plastic conduit in a variety of electrical applications are detailed in this 6-pp bulletin of Southwestern Plastic Pipe Co. Mechanical, physical and electrical properties and other data are tabulated and installation discussed.

290 General Purpose Controls — Catalog 1260D, 72 pp, contains information on general purpose control devices available from General Electric Co. Charts are listed for motors from ¼ through 200 hp, affording quick selection of heaters and push button stations. Product descriptions are provided for both manual and magnetic motor starters, relays, solenoids, limit switches, push buttons, static control and pilot devices. Pricing tables are included.

291 Voltage Regulators — Distribution voltage regulator features designed to provide more economical and better voltage regulation are described by Allis-Chalmers Mfg. Co. in 16-pp Bulletin 21B7977E. Describes unit construction, electrical re-settable position indicator, other features.

292 Electric Motor Controls — Pocket Catalog 60, published by Furnas Electric Co., 56-pp, gives descriptions, ratings, prices for manual and magnetic starters, drum controller, pressure, foot and limit switches. Included are push buttons, related pilot devices, motor rating, heater coil data, and selection tables.

293 Electric Motor Controls — Contained in 72-pp Catalog 5900 of Furnas Electric Co. are selector charts for magnetic and manual starters, giving horsepower, motor speed, heater size, heater ampere ratings, enclosure choices. Covers manual starters, magnetic controls, drum controllers, pressure switches, others.

294 Reduced Voltage Starter — Eight-pp Bulletin GEA-6860, General Electric Co. defines reduced voltage starters, tells when and where to use them and how to select them. Contains starter selection table and comparison table. Shows the manual autotransformer, magnetic autotransformer, primary resistor. Part winding starters, schematic connection diagrams are included.

295 Circuit Breaker Accessories — Twelve-pp Bulletin GEA6757 describes General Electric Co.'s industrial molded case circuit breaker accessories and modifications for a variety of control applications. Includes detailed selection data, outline dimensional drawings.

296 Circuit Breakers — Low voltage stored-energy power circuit breakers are discussed by General Electric Co. in a 20-pp Bulletin GEA-5915E. Includes photographs, diagrams, graphs, charts showing specifications, operating features, dimensions, ratings for low voltage power circuit breakers and applications. Manual and electrical stored-energy closing mechanisms are described.

297 Unit Substations — Comprehensive Workbook PSG-6001, 24-pp, aids in planning articulated unit substations for secondary distribution, and features a suggested specification form detailing data for a properly coordinated substation system. Ratings, weights and dimensions are included. Detailed specifications provided by Pennsylvania Transformer Div., McGraw-Edison Co., for incoming supply sections, transformer sections and outgoing feeder assemblies.

298 Unit Substations — Detailed information on features, operations and application of selectively-coordinated load center unit substations providing continuous power for a-c distribution systems is presented in 32-pp Bulletin GEA-3592L of General Electric Co. Compares types of load center arrangements and explains how selective coordination of load centers can be provided on any of four basic industrial and commercial building power distribution circuits.

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299 Industrial Power Systems — Principles of planning industrial power distribution systems for safety, reliability and economy while retaining flexibility and provisions for future expansion are outlined in General Electric Co.'s 48-pp Bulletin GEA-7139. Chapters cover choosing voltages, short circuit calculations, protective relaying, selection of unit substations, power factor corrections.

300 Electrical Distribution — Comprehensive information on electrical distribution products is presented in this 60-pp catalog of I-T-E Circuit Breaker Co. Divided into three main sections covering molded case circuit breakers, individually-enclosed low-voltage power circuit breakers, and engineered products, it contains selection and application data, selection charts listing types, ratings.

301 Electrical Distribution, Control — Complete with photos, tables of specifications, pricing information, wiring diagrams, this 155-pp reference catalog of Federal Pacific Electric Co. covers 30 types of products. They include circuit breaker load centers, fusible service equipment, enclosed safety switches, low voltage fuses, molded case circuit breakers, enclosed industrial breakers, wall mounted air breakers, bolted pressure contact switches, lighting and distribution panelboards, others. Book is available to qualified power engineers.

302 L-V Distribution Equipment — General Electric Co.'s 84-pp, 1960 Buy Log covers log-voltage distribution equipment. It serves as a condensed buying catalog for service entrance equipment, light and heavy duty safety switches, tumble and open-knife switches, hinged wireway, circuit breakers, switchboards, motor control centers, sectional distribution centers, panelboards and busway.

303 Overload Fault Currents — Sixteen-pp Section 7 of an aluminum conductor engineering data series offered by Aluminum Co. of America, discusses overload and fault current limitations of bare aluminum conductors. Includes graphs showing maximum allowable time for various high value emergency or short circuit currents.

304 Industrial Capacitors — Twelve-pp Booklet B-7642, Westinghouse Electric Corp., answers questions concerning use of capacitors to reduce power costs, increase system capacity, and apply to industry. Subjects cover power factor, benefits of capacitors, how to select capacitors, and where and how to apply.

305 Interrupting Capacity Chart — This chart, prepared by Westinghouse Electric Corp., aids in selecting and ordering proper circuit breaker for each application. Interrupting ratings, available fault currents covered.

306 Basic Electrical Protection — Ten-pp Bulletin BPB issued by Bussmann Mfg. Div., McGraw-Edison Co. gives information on motor protection, system selectivity to faults, fuse application and fuse selection. Tells how to coordinate opening time of protective device so that a fault current will be isolated to the circuit of origin and includes charts showing time of opening and current limitation.

307 Testing Instruments — Twelve-pp Bulletin 19-60 contains descriptive information on industrial instruments available from James G. Biddle Co. They include electrical resistance testers, dielectric test sets, cable fault locating equipment, turn ratio test sets, and others.

308 Portable Test Units — Presented in this 48-pp booklet of Multi-amp Electronic Corp. is detailed information on portable test units for protective relays. Subjects treated include classification of relay tests; preparation for protective relay testing; reasons for an adequate testing and maintenance program.

309 Silicon Rectifiers — Booklet B-7900, which tells why silicon rectifier packages offer d-c power saving to the electrochemical and allied industries, is offered by Westinghouse Electric Corp. This 20-pp publication presents detailed description of a silicon power package and states advantages of silicon over other types.

310 Insulation Materials — Illustrated 36-pp Catalog 34 presents electrical insulation for repair and maintenance of motors, generators, and electrical or electronic equipment. Prepared by Insulation Manufacturers Corp. covers packaged insulation products: cotton, asbestos, and woven glass tapes; cotton, glass and varnished or saturated tubing and sleeving; mica plates and laminates; varnished fabrics; insulation papers; others.

311 Electrical Insulating Oils — Bulletin 58, 6 pp, gives technical information on Sun Oil Co.'s insulating oils for transformers and cables. Discusses functions of a transformer oil; gassing characteristics of oils, properties of electrical oils, uses for inhibited and uninhibited oils.

312 Electrical-Insulating Varnish — This 36-pp catalog of Minnesota Mining & Mfg. Co. covers selection and application of electrical insulating varnishes with complete details on all electrical and mechanical properties as well as operating temperature limitations. Includes charts, graphs and illustrations.

313 Printing Demand Meters — General Electric Co.'s Bulletin GEA-6892, 8-pp, describes printing demand meters for precision recording of loads. Discusses application, design, and cost of PD-55F and PD-57F meters. Includes operating, construction, electrical specifications.

314 Battery Technology — Bulletin GB-1896 is a 36-pp handbook of technical instructions and engineering data on the care of motive power storage batteries offered by Gould-National Batteries, Inc. It covers all phases of lead acid battery theory, operation and maintenance.

315 Battery Chargers — Selenium or silicon rectifier battery chargers designed for station-type batteries used by utilities and industrial plants are described in this product bulletin of Syntron Co. Specifications, data and descriptions of standard models from 15- to 200-amp.

316 Tungar Bulb Data — Eight-pp Publication ETR-2091, a revised edition of General Electric Co.'s manual on Tungar bulbs, contains typical circuits and operating data. Also provides descriptive and theoretical data on use of Tungar bulbs in rectifier circuits to provide noise-free power supplies with low voltage drop and high efficiency.

317 Commutator Maintenance — This commutator and slip ring maintenance data file of Ideal Industries, Inc. contains information on methods and procedures for more efficient commutation. Individual bulletins cover brushes, sparking, picking, dragging and other troubles, maintenance tools and how to use them.

318 Electrical Equipment Guide — Describing heavy duty electrical transmission and distribution equipment for commercial, industrial and other installations, this catalog digest of Continental Electric Equipment Co. contains detailed specifications. Presents interrupter, switches, medium voltage switchboards, unit substations, power centers, low voltage switchgear, panel type switchgear, bus ducts, bus plugs, motor control centers, panelboards, circuit breakers, others. Available to qualified power engineers, please state your job title.

319 Channel Fittings, Hangers — This pocket-size reference type work manual, about 68 pp, contains product illustrations and correlated information for specifying and using structural support materials for electrical installations. A publication of Steel City Electric Co., it is indexed to sections identified with specific areas of applications . . . as for suspending single and multiple runs of conduits; building racks and frames; concrete inserts; beam clamps for fastening to structures; brackets and supports.

If the catalog you're looking for isn't listed here, please tell us about it. The chances are, we can get it for you.

320 Low-Voltage Switching — Twenty-pp Electrician's Manual RM-610 offered by Remcon Div., Pyramid Instrument Corp., contains an introduction to low-voltage switching. Explains how company's remote-control switching works electrically, how components are mounted, how to plan a layout.

321 Power Supply Handbook — Specifications on regulated d-c supplies, frequency changers (variable frequency power sources) high-voltage power supplies (to 600 kv) and other high-voltage products, miniature transistorized power supplies, inverters and converters, and a-c line-voltage regulators are presented by Sorensen & Co., Inc. in this 32-pp handbook.

Dust Control

322 Dust Collection, Recovery — A series of product bulletins on Western Precipitation Corp.'s dust collection, precipitation and gas scrubbing equipment is provided in this literature folder. Equipment described includes electrical percipitators, mechanical dust collectors, gas scrubbers, high temperature dust collector, reverse-jet equipment, others.

323 Dust Collectors — Included in 16-pp Bulletin 1828, American-Standard,

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is a list of typical industry dust control applications . . . for power plants, steel production, cement and aggregate production, chemical and petroleum processing, food and grain processing and general manufacturing. Covers operating characteristics, construction features.

325 Electronic Air Cleaner — Twelve-pp Bulletin 405, Dollinger Corp., describes features and advantages of an electronic air cleaner based on the principle of electrostatic precipitation. Diagrams, photos specifications included.

326 Mechanical Dust Collectors — Recent improvements in mechanical dust collectors including a new involute design are described in 8-pp Bulletin 300 of Research-Cottrell, Inc. Contains detailed drawings and application diagrams.

Motive Power

327 Large Generating Units — Design and construction features of large steam turbine generating units are illustrated and described in 40-pp Bulletin 03B9448, Allis-Chalmers Mfg. Co. Subjects covered range from compact component design to controls and instrumentation. Illustrated with photos, drawings and section diagrams. Includes ratings.

328 Gas Turbines for Peaking — Peaking combustion gas turbines with capacities from 7,000 to 28,000 kw are described in 12-pp Bulletin GED-3761, General Electric Co. Outlines savings possible through lower installed cost, minimum space and personnel requirements, less transmission equipment investment, lower line losses.

329 Gas Turbine Power — Eight-pp Bulletin GEA-7083 of General Electric Co. introduces a line of 75 to 20,000-hp ultra-lightweight, compact gas turbines for a wide variety of applications, including fluid and gas pumping, electric power generation. Covers design features, performance and operating characteristics, current and potential applications.

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330 Steam Turbines — Advantages of company's solid wheel turbines, axial flow turbines, single stage and multistage, are outlined by The Terry Steam Turbine Co. in illustrated Bulletin S-140. Describes various models in their line and includes application photos.

331 Steam Turbines — Single stage turbines for mechanical drives are featured by Murray Iron Works Co. in 6-pp Bulletin T-126. Schematic drawings showing component features and details of operation and design included.

332 Gas Turbines — The power concept of The Cooper-Bessemer Corp.'s gas turbine based on the J-57 jet engine is discussed in 8-pp Bulletin 95. Describes operating characteristics, thermal efficiencies, maintenance costs, and potential applications, and includes schematic drawings, performance curves.

333 Standby Generator Sets — Described by General Motors Corp. in this 8-pp bulletin is a line of diesel powered standby generator sets for emergency power. Gives complete specifications on single and multiple-engine sets.

334 Gas Turbine Engines — Featured in this 24-pp bulletin of Solar Aircraft Co. are engine data, performance curves and applications for gas turbine engines. Explains operation of gas turbines and includes application photos.

335 For Standby Power — Selection and installation of standby electric plants and controls is fully detailed in this 8-pp bulletin by D. W. Onan & Sons, Inc. Practical suggestions are offered on planning and designing the installation.

Safety, Fire Protection

336 Personal Safety Equipment — Catalog 59, 76-pp, of Wilson Products Div., Ray-O-Vac Co., covers four general types of personal safety equipment: eye protective wear; respiratory protection; hearing protection; and headgear. Detailed product descriptions show individual components and parts, and charts recommend specific equipment for each hazard.

337 Equipment for Linemen — This 32-pp catalog of Charleston Rubber Co. describes high voltage rubber protective equipment for linemen, giving instructions as to its proper care and use. Also lists technical reports available, including a glove care poster, and provides a glove selector chart. Among products featured are gloves and sleeves, glove protectors and innerliners; danger flags.

338 For Fire Protection — Folio 1 of Chemetron Corp.'s Cardox Div., is a 12-pp revised booklet on fire extinguishing systems and equipment. Lists principal causes of large-loss fires, advantages in use of carbon dioxide, and examples of extinguishing installations in steel, general manufacturing, electrical and other industries. Shows typical systems for protection of generators, flammable liquids.

339 Fire Alarm Systems — Publication 246 of The Standard Electric Time Co. contains 36 pp of detailed information on fire alarm systems for critical applications in industrial, institutional and other public buildings. Contains typical job specifications covering all systems.

340 Handling Flammable Liquids — Problems involved in use of flammables and methods and equipment required for safe control are described by The Protectoseal Co. in this 76-pp safety handbook. Physical properties and characteristics of most commonly used flammables are detailed, and recommendations for safe handling of these liquids given.

341 Fire Extinguishing Equipment — Shown by Ansul Chemical Co. in 20-pp Catalog 1960 are hand portable extinguishers, stationary fire equipment, piped systems, and large capacity mobile equipment such as fire jeeps and trucks. Capacity data on various types of extinguishers and other equipment presented.

342 Fire Control Tips — This fire control chart, AD3003R8, shows fire extinguishers and gives detailed information including ratings. Prepared by Walter Kidde & Co, Inc., gives data on Class A, B and C fires and suitable extinguishers.

343 Special Fire Protection — Devoted to special hazard fire protection, this 44-pp booklet of Grinnell Co., Inc. covers both equipment and methods. Tells how to recognize special fire-hazardous conditions in a plant. Discusses major types of fire protection, telling how each functions, giving it advantages and limitations.

344 Chain Safety Kit — Answers to questions regarding the care, use and inspection of sling chains are given by The McKay Co. in this safety kit. Consisting of five folders, each dealing with a different aspect of chain safety, it covers inspection procedures, safety precautions and terms, working load limits, proper care and use.

345 Fire-Retardant Paints — Twelve-pp pocket-size Bulletin 100 of The Albi Mfg. Co., Inc., tells how fire-retardant paints reduce potential fire damage. Explains significance of the "safety margin" of extra time at start of a fire as related to protective action of paints on combustible building material, structural metal.

346 Color for Safety — Offered by Valdura Heavy-Duty Paint Div., American-Marietta Co., this 6-pp booklet shows a cutaway section of a typical industrial plant with all danger areas painted in appropriate safety colors. Lists recommended colors for every safety application.

347 Self-Sticking Identification — Products designed to aid in industrial maintenance and safety identification programs are illustrated and described in 32-pp Catalog 520 of W. H. Brady Co. Covers piping marking systems, identification of plant wiring and electrical equipment, lubrication marking, marking for hazardous areas and equipment.

348 Markers, Signs — Illustrated in full color, this 24-pp catalog of North Shore Nameplate Div., Anodyne, Inc., provides information on pipe and electrical markers, numerals, letters, safety and identification signs all available from stock. Explains how markers are applied, also includes prices, ordering information.

Postage-free Reader Service Cards are on pages 87-88

Maintenance, Shop Equipment

349 Heavy-Duty Electric Tools — Twelve-pp Condensed Catalog G20, Milwaukee Electric Tool Corp., illustrates and describes heavy-duty electric tools, including drills, saws, shears, hack saws, generators, grinders, hammers, screw drivers, nut runners, sanders and polishers.

350 Pneumatic Tools — Described in Catalog PT-58, about 12 pp are portable pneumatic production tools including grinders, attachments and accessories, wire brushes, hose and fittings, air line controls of Thomas C. Wilson, Inc. Provides design features, application suggestions, sizes.

351 Tips on Grinding Wheels — Over 1600 abrasive wheel recommendations for grinding everything from agate to zirconium are set up in alphabetical order by The Carborundum Co., in this specification catalog, about 57-pp. Material, work, operation — with their respective recommendations on abrasive, grit, grade and bond — are listed.

If the catalog you're looking for isn't listed here, please tell us about it. The chances are, we can get it for you.

352 Guide to Preheat — Welding of low-alloy high-tensile steel and other alloy steels with the aid of preheat is explained by J. B. Nottingham & Co., Inc., in 40-pp "A Guide To Preheat." Physical and chemical changes that take place in these problem steels during and immediately after welding are outlined.

353 Air and Electric Tools — Drilling, fastening, abrasive and special tools (such as saws and routers), as well as electric tools and accessories are featured in 72-pp Catalog 61 offered by Buckeye Tools Corp. Complete selection details and specifications are included.

354 Tool Buyers' Guide — Catalog 60, complete with specifications and prices, is a 68-pp ordering book on Double Circle tools of Chicago Latrobe. Covers drills, reamers, end mills, countersinks, carbides, counterbores, others. Also provides information on features and applications; includes section on drill facts.

355 Grinding Wheel Chart — Information contained in this chart is based on rules and regulations established by the American Standard Safety Code for use, care and protection of abrasive wheels. Prepared by the Grinding Wheel Institute, it lists "do's and don'ts" of wheel care.

356 How to Bend Conduit — This 12-pp pocket-size booklet of Appleton Electric Co. gives instructions for making precision bends in electrical metallic tubing, rigid steel, and rigid aluminum conduit. Covers five fundamental bends — angle bends, stub lengths, back-to-back bends, offsets and three-bend saddles. Diagrams show techniques for on-the-spot bending of small conduits. Includes offset formulas, shrink tables and "gain" tables.

357 Conduit Bending — Illustrated Bulletin 260, on bending conduit or pipe easily and accurately, features an improved bender. Prepared by Lidseen of North Carolina, booklet covers calculating lengths of legs, locating bend, back-to-back method, back-to-back push-through.

358 On Welding Electrodes — Contained in this 64-pp electrode pocket guide of Air Reduction Co., Inc. is information on all types of electrodes including mild steel, low alloy, low hydrogen, iron powder, stainless steel, hardfacing, non-ferrous and cast iron. Covers applications, procedures and pertinent data on each electrode, includes charts of electrodes for welding various steels, and tables for mild steel and hardfacing electrodes.

359 Arc Welding — Basic information concerning arc welding techniques for small diameter piping is contained in Lincoln Electric Co.'s Bulletin 2112.3. Lists advantages of welded piping installations; describes procedures, explaining calculation of welding costs. Recommends suitable types of electrodes.

360 Welding Data — This 148-pp pocket-size maintenance welding data book, issued by Eutectic Welding Alloys Corp., provides a guide, indexed by application, to nearly 200 rods, electrodes, and chemical aids. It illustrates and explains general welding techniques and joint design hints, and covers elimination of warping, distortion, embrittlement and other base metal damage; wear, impact and corrosion resistance.

361 Equipment for Welding — Gas welding, cutting and allied equipment of Smith Welding Corp. is covered in this 40-pp manual. Book is arranged in six sections. Charts and technical data are provided. One section covers flow capacity curves for gas pressure regulators.

362 Tips on Welding — This 56-pp welding, brazing and soldering alloy and flux catalog and instruction manual issued by All-State Welding Alloys Co., Inc. covers physical properties, major uses, detailed application instructions and latest techniques for welding, brazing, soldering, cutting and hardfacing.

363 Manual Welding Equipment — Described in 20-pp Catalog F-8982E is Linde Co.'s manual welding equipment using an inert gas to protect the weld zone from the atmosphere. Various types of welding torches and accessories for welding of commercial metals covered.

364 Vest Pocket Welding Guide — This revised edition of "How to Get Better Welds," published by Hobart Brothers Co., contains 80 pp of arc welding information. Covers essentials for proper welding procedures, good and bad welds, welding positions, operator qualifications, welding metals and steel available for welding. Also deals with causes and cures of common welding troubles, check points for quality welding, cost saving, safety precautions. Electrodes and factors to consider when selecting them are discussed.

365 Maintenance Equipment — Catalog No. P-9, 24-pp, provides pulling systems, photos of Grip-o-matic and push-pullers, Power-Twin "center hole" rams, pumps and hydraulic shop presses offered by Owatonna Tool Co. Shows how these units remove and install gears, bearing, pulleys, shafts and couplings simply and quickly.

Catalogs reviewed here are offered primarily for qualified power engineers. Manufacturers may withhold literature from persons who do not state their job title and company. Some manufacturers also prefer not to send literature to those in foreign countries in which they have no sales representative.

366 Brazing Techniques — This 24-pp manual contains data for brazing shapes, sheet, castings, tubing and assemblies of aluminum, cast iron, copper, brass and steel. Covers such basic functions as heat, flame and torch settings, alloys selection and joint design. Solutions to common brazing problems are answered by All-State Welding Alloys Co., Inc.

367 Soldering Tools — Catalog S-60 of Ungar Electric Tools contains 8 pp of detailed information on soldering tools featuring interchangeability. A temperature chart for various applications is included.

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Lighting

368 Floodlight Data in Brief — Pocket-sized Bulletin 2714 is a 184-pp miniature edition of Crouse-Hinds Co.'s floodlight catalog, and includes all original material. Covers selection of floodlights, general purpose floodlights, heavy duty models, mercury vapor floodlights, special types, lighting for hazardous locations, searchlights, poles, accessories. Includes installation tips, lighting calculations.

369 On Floodlighting — Bulletin GEA-7201, 10-pp, stresses value of good floodlighting, and gives application data and product information on filament, mercury vapor and fluorescent units. Photos show typical applications. A publication of General Electric Co., also tells how to get more light per dollar.

370 Area Floodlighting — Planning for lighting of parking areas and other open areas is detailed by Crouse-Hinds Co. in 16-pp Bulletin 2719. Contains reference guides for selecting incandescent or mercury floodlights, general purpose or heavy duty types, and for determining how many floodlights are needed.

371 Incandescent Lighting — The 24-pp "Incandescent Lighting Guide Book" of Sylvania Electric Products Inc., features sections on the general advantages of incandescent lighting, the history of incandescent lamp developments, and includes chapter on basic types, bulb shapes, sizes, glass types and finishes, and bases.

372 Group Relamping Plan — Eight-pp Booklet A-6832 describes a group relamping plan designed by Westinghouse Electric Corp. to reduce costs, provide better lighting, and cause fewer work interruptions. Sample calculations provide data for setting up a schedule.

373 Lighting Maintenance Tips — Principles and advantages of good lighting practice are presented in Champion Lamp Works' 48-pp lighting maintenance manual. Includes guide to trouble shooting fluorescent installations, tips on planning group lamp replacement cleaning.

374 Vapor-Tight Fixtures — Presented in this 52-pp catalog supplement of Killark Electric Mfg. Co. are vapor-tight aluminum lighting fixtures. They include pendant, ceiling and bracket types for a variety of installations. Reflector styles — shallow bowl, standard dome or angle — are also described.

375 Lighting Specifications — Included in the 52-pp RLM Standard Specifications are three new specifications for 1500 ma units: D-4 fluorescent semi-direct medium high mounting, SD-3AL semi-direct aluminum, and SD-3PE semi-direct porcelain enamel units. The book contains many upward revisions of existing specifications, and new specifications for aluminum reflectors. Booklet is prepared by The RLM Standards Institute, Inc.

376 Modern Lighting Needs — "Footcandles in Modern Lighting," is General Electric Co.'s 20-pp revised booklet giving lighting level recommendations for seeing tasks involved in hundreds of industrial and other activities. Figures are based on findings of Illuminating Engineering Research Institute and Illuminating Engineering Society. Also discussed are other aspects of lighting to be considered.

377 Lamp Ballast Service — Described by Universal Mfg. Corp. in this product bulletin is a service program for fluorescent lamp ballasts which provides immediate replacement of inoperative ballasts. Also described is a 24-hr engineering service for design consultation, installation assistance or trouble-shooting.

378 Miniature Lamp Data — This 24-pp pocket size booklet of Chicago Miniature Lamp Works lists standard miniature lamps now available, and the sources of supply from which they may be obtained. Specifications of the lamps (nearly 400) are given, also lamp nomenclature.

Automation, Instruments and Controls

379 Automatic Controls — Comprehensive data on mercury-switch equipped controls for single-stage pressure, two-stage pressure, differential pressure, single-stage temperature, two-stage temperature, liquid level and mechanical movement are presented by The Mercoid Corp. in 56-pp Catalog 860. Specifications and engineering data provided.

380 Telemetering Systems — Metameter telemeters for remote measurement, recording and automatic control are described in 52-pp Bulletin M1715 of The Bristol Co. Covers principles of operation, types; application to various factors including pressure, water level, temperature, flow, motion and position; and electrical quantities.

381 Metering Control Systems — Bailey Meter Co.'s Bulletin 500 describes purpose, design and operation of company's metering and control systems. Includes discussion and pneumatic control, along with detailed literature references.

382 Industrial Controls — This 88-pp catalog presents comprehensive information on controls, offered by General Controls Co., including automatic temperature, pressure, level and flow controls, as well as counters, switches and automation controls. Other items described are industrial actuators, combustion instrument controls, controller indicators and pressure indicators.

383 Temperature Controls —Filled with charts, drawings and diagrams, 24-pp Bulletin 101, of the Partlow Corp., discusses industrial temperature measurement and control, including ways of responding to temperature, ways of putting temperature response to work, mercury-bulb instrumentation, basic types of controls, and a score sheet for the mercury-bulb system. Also covers basic concepts of control instrumentation.

384 Feed Regulator Level Control — Basics in the control of feeders which are operated by electric motors or electric vibratory mechanisms, and the controlling equipment, are described in this 6-pp bulletin of Industrial Instruments, Inc. Tells how the electronic feed controller works and how to install and start control.

385 Ideas on Push-Pull Controls — Included in this "Idea File" of Automotive & Research Div., American Chain & Cable Co., Inc., are answers to a power engineer's questions on the use of push-pull controls. A general information booklet discusses remote control applications, explains construction and operation of Tru-Lay controls. Separate bulletins are devoted to standard assemblies, bracket-type head controls.

386 On Thermocouples — Detailed information on thermocouples and thermocouple components and accessories is contained in 50-pp Catalog EN-82 of Leeds & Northrup Co. Lists and describes standard assemblies in protecting tubes and wells for general applications; specialized thermocouples and assemblies; and bare and insulated thermocouple wires, replacement elements, protecting tubes.

387 How to Select Recorders — Buying information on recording instruments of General Electric Co. is provided in 12-pp Bulletin GEA-6933, including dimensions and chart speeds, operating specifications, applications, features and accessories. Also described are specialized recording instruments — recording vibrometers, automatic oscillographs, self-balancing potentiometers.

388 Mass Flowmeter — Bulletin GEA-6925, 8-pp, describes theory, operation and advantages of General Electric Co.'s flowmeter that measures flow of fuels, industrial liquids, and gases directly in pounds. Gives ranges, specifications.

389 Leak Detector — Instructions on use of halogen leak detectors for finding leaks in enclosures that can be pressurized, in such applications as steam boilers, valves, piping, transformers, air-conditioning and refrigeration equipment are

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given by General Electric Co. in Bulletin GET-2936, 6 pp. Discusses system preparation, testing procedures, calibration.

390 Rotameters, Flow Indicators — Condensed Bulletin M-1 features Schutte and Koerting Co.'s instruments for measuring indicating, recording and controlling rate of flow of all types of fluids. Various rotameters are described, also flow indicators for installation in pipe lines where it is necessary to observe fluid.

391 Test Instruments — Catalog G-10 contains 48 pp of data on measurement, recording, and testing instruments of Minneapolis-Honeywell Regulator Co. Covers are d-c amplifiers, data handling systems, calibration instruments, magnetic tape instrumentation, nuclear instrumentation, oscillographs, recorders and indicators, servo components, temperature controllers, transducers.

392 Pressure Gages — Featured by J. E. Lonergan Co. in 46-pp Catalog 1000G are pressure indicating and vacuum gages for industrial, chemical, and refinery applications. Selector tables give data on various gages and recommended services. Specifications, standard graduation tables, photos, dimension diagrams included.

393 Hydrostatic Instruments — In this 88-pp pocket-size handbook of hydrostatic instrumentation, Petrometer Corp includes information on principles of hydrostatic measurement, selection and installation of instruments, design and construction of panel systems, as well as engineering data and diagrams. Provides tank volume formulae, conversion tables, viscosity charts, hydrometer scales, specific gravity tables for various liquids.

394 Water Level Gages — Twelve-pp Bulletin WG-1815 describes Yarnall-Waring Co.'s color-port gages for medium boiler pressures to 1050 psi, and high pressures to 3000 psi. Details of gages, water columns, color-port inserts, and gage valves are given, with dimensions, data on transmittal of readings, servicing.

395 Guide to Gages — Catalog 300-B, 112 pp, features Ashcroft, Dura-gauges, Maxisafe, pneumatic receiver, recording, drawn case, chemical and special application gages of Manning Maxwell & Moore, Inc. Also presented are gage testers, pneumatic transmitters, gages for nuclear energy. Engineering data and charts are provided. Instruments shown cover dial sizes from 2 through 24 in.

396 Draft Gages, Instruments — Bulletin 354-B is a condensed catalog of Ellison Draft Gage Co., Inc., covering stationary and portable draft gages, pitot tubes, air filter gages, gas analyzers, steam calorimeters.

397 Motor Operators, Valves — Catalog 407, 24 pp, describes electric motor operators and motorized valves of Schade Valve Mfg. Co. and introduces a reversible, proportional unit. Covers features, construction details, applications, dimensions. Valves described include butterfly, rotary disc, balanced globe, three-way, fuel control, others.

398 Automatic Controls — Selection and application information on automatic controls for steam and water service is presented by The Powers Regulator Co. in 46-pp Engineer's Manual. Covers controls for fuel oil heaters, heat exchangers for cooling, instantaneous heat exchangers, jacket water cooling, process hot water, pressure reduction, storage heaters, two temperature hot water systems.

399 Automatic Combustion Control — In Bulletin E-104, Reliance Instrument Mfg. Corp. describes automatic combustion controls for oil, gas or coal fired boilers. Features and advantages of various types of controls for economic steam generation are outlined.

400 Timers and Counters — Condensed Catalog D-31 contains 30 pp of reference data on automation components and control systems, covering latest timing components and linear measuring systems. Standard timers and counters are reviewed as well as electronic timers, package control systems, test equipment, switches, controllers, contactors and other products of Automatic Timing & Controls, Inc.

401 Feedwater Regulator — Bulletin 1045 released by Copes-Vulcan Div., Blaw-Knox Co., describes a feedwater regulator with two-element regulation, one control element responding to changes in rate of steam, the other to variations in boiler water level.

402 Nuclear Instrumentation — Detailed information on nuclear instrumentation and accessories is presented in 50-pp Condensed Catalog F of Tracerlab, Inc. Covers all phases of nuclear study and includes detectors, counting and radiation analysis equipment, sample changing equipment and necessary adjuncts for personnel protection, monitoring.

403 Turbine Instruments — Bulletin GEZ 3078-1, 12 pp, includes description and specifications of General Electric Co.'s compact redesign of a turbine supervisory instrument system that charts a permanent record of mechanical performance throughout starting and running periods. Detailed description of system's ability to monitor vibration, shaft eccentricity, shell and differential expansion, speed and valve position is included.

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404 Water Columns — Brochure AO explains principles and construction of Reliance Gauge Column Co.'s low pressure alarm water columns and lists accessory equipment. Introduction to low pressure (0 to 250 psi) division of catalog data.

405 Instruments and Controls — Catalog 57-6, Republic Flow Meters Co., describes instruments and controls, including flow meters, liquid level or pressure gage, CO_2 meters, boiler meters, pneumatic transmitters, strip chart recorder, pressure, vacuum and differential recorder, temperature recorder and others.

406 Instrument Tubing — Information on instrument tubing and accessories is presented in this 16-pp bulletin. Described are extruded polyethylene tubing, extruded nylon tubing, tubes of copper, aluminum, and/or steel with polyethylene sheath, tubing with vinyl sheath, bundled instrument tubing-products of Dekoron Products Div., Samuel Moore & Co.

407 Process Control Systems — This 12-pp booklet of Daystrom, Inc., outlines company's industrial process control systems, covering such subjects as the benefits of a total systems approach. Discusses flexibility of a typical control system, listing the control-associated functions performed.

408 Continuous Stream Analyzers — Illustrated and described in 8-pp Bulletin CL-4000 is a line of continuous stream analyzers, including pH equipment, gas chromatographs, infrared analyzers, oxygen analyzers, electrolytic hygrometer, flow colorimeter, and thermal conductivity gas analyzer. Typical applications are listed by Beckman Instruments, Inc.

409 Compiler-Translator — Act I, an electronic algebraic compiler and translator, is described in 18-pp Manual S-520 of Royal McBee Corp. Explains "source" program language — a series of algebraic and logical statements. Stresses simplicity of use, faster programming and thus faster computer solutions.

410 Computer Control System — Details on PowrMag solid state analog computer control systems are presented in Bulletin MSP-163, Hagan Chemicals & Controls, Inc. Diagrams show interchangeable circuits possible for various control functions. Applications are suggested, with emphasis on centralized plant or multi-plant control, expansion of facilities.

411 Automation Components — A 30-pp reference for automation components and control systems, Condensed Catalog D-31 describes latest timing components and linear measuring systems for industrial use available from Automatic Timing & Controls, Inc. Sections are devoted to electronic timers, special timers and their applications, package control systems, test equipment, controllers.

412 Teaching Servo Systems — A new method of teaching servo systems that bridges the gap between theory and practice is described in 8-pp Special Report SR-3 by Servo Corp. of America. Explains how packaged assembly of electronic and electrochemical components permits students to build and test servo systems, demonstrates formula derivation, characteristics of control systems.

413 Data Processing at Work — Data processing equipment of Leeds & Northrup Co. now in use throughout the country is described in 48-pp Preliminary Technical Publication N-07(1). Installations covered include digital data processing and analog and digital computing systems. Explains types of inputs, input switching, output devices and modes of operation for applications in electric-power, petro-chemical, other fields.

414 Automation for Utilities — Automated equipment and systems for electric utilities are described in General Electric Co.'s Bulletin GEA-7044, 244 pp. All phases of system operation — generation, transmission and distribution — are covered, as well as automatic load dispatching covering the areas of load-

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frequency control and economic loading to minimize transmission losses.

415 Servo System — Instruction Manual 60-77, 12 pp, describes the electro hydraulic building block velocity servo system of Vickers Inc., Div., Sperry Rand Corp. It is intended as an aid in setting up and trimming the servo system, with step-by-step descriptions of procedure.

416 Indicating-Alarm System — Features and advantages of the Omniguard indicating and alarm system by Thomas A. Edison Industries for monitoring temperatures and pressures are illustrated and described in Publication 3036C.

Another Reference File of Commercial Literature is in preparation and will appear in a few months. The editors welcome your suggestions for making this department of greatest value to you

417 Alarm/Control System — Bulletin ECM 119, about 16 pp, of General Electric Co., describes a high-capacity alarm/control system providing an inexpensive method of locating faults at unattended operations and controlling on-off functions remotely. Tells how equipment can be "customized" to suit specific supervisory or control needs.

418 Data Logging System — Technical data on all functions of the Kybernetes Series 2000 Data-Logging System are presented in this 12-pp bulletin by Hagan Chemicals & Controls, Inc. Covers inputs, d-c amplification, analog-to-digital conversion, linearization, programming, integration, computer control and others.

419 Annunciator Systems — Well illustrated with photos, charts and diagrams, 52-pp Catalog 100C of the Panalarm Div., Panellit, Inc., presents information on annunciator systems designed to give immediate notification of off-normal conditions in continuous process and automatic operations. Discusses function and applications of annunciators.

420 Lamp Annunciator Systems — Bulletin A-200, 24 pp, presents outstanding features and operational details of modular industrial lamp annunciator systems for supervision, process control automation systems available from Edwards Co., Inc. Includes system selector chart, ordering information.

421 Signaling Equipment — Air and electric signal systems and specifications of horns, bells, buzzers, chimes and sirens are featured in 88-pp Catalog 160 by Sperti Faraday, Inc. Included are sections on gravity drop and lamp type annunciators and accessory equipment, and charts and diagrams for selection of proper type signal for various background noise levels and work areas.

422 Annunciator Systems — Information on operation and application of annunciator systems for continuous and automatic surveillance of pipeline, chemical and food processing, power generation and distribution is given by The Scam Instrument Corp. in 36-pp Catalog 659. Types of annunciator sequences are illustrated.

423 Computer Talk — This 22-pp glossary of "computerese" — the language of electrical brains — is compiled by Minneapolis-Honeywell Regulator Co. to make computer language more intelligible to the layman. Defines over 82 terms found in the vocabulary of industrial process computer engineers.

Lubrication

424 Turbine Lubrication — Basic lubrication requirements for turbines and gears are detailed by Murray Iron Works in Bulletin T-125-A. Sections cover care of the oiling system, turbine lubricants, lubricating oil recommendations, reduction gears and geared units.

425 Solid Lubricants — Theory and practice of lubrication by solids are discussed in 24-pp Bulletin 124 by The Alpha-Molykote Corp. Tells advantages of molybdenum disulfide solid lubricants.

426 Organized Lubrication — Benefits of organized lubrication are extolled by Texaco, Inc. in this 24-pp bulletin. Cost control opportunities are detailed, and task of assigning responsibilities in an organized lubrication system are discussed.

427 Lubricant Data — Characteristics, advantages of specialized fluid and grease type lubricants are described in 32-pp Data Book 59-2, by Lubriplate Div., Fiske Bros. Refining Co. Includes sections on control of friction, use of grease type lubricants, proper applications, and recommendations for various conditions.

Metals

428 Steel Analysis — In this 20-pp pocket-size booklet, Jones & Laughlin Corp. lists compositions of 40 stainless steels, 184 alloy steels and 105 carbon steels most often used in industry. It also contains federal specifications with corresponding SAE, AISI and AMS numbers.

429 Steel Weight Tables — This 72-pp booklet, released by Jos. Dyson & Sons, Inc., contains weight tables of steel, including weights of round, square, hexagon, octagon, and flat steel bars in a wide range of thicknesses. Also includes decimal equivalents, tables of area and circumferences.

430 Rugged Castings — Properties and applications of heat and corrosion resistant castings are given in this 64-pp booklet of The International Nickel Co., Inc. Designed to aid in stainless steel and high-alloy casting selection, it offers comprehensive data on all types of stainless steel and high-alloy heat.

431 Ferrous Metallurgy — "Basic Guide to Ferrous Metallurgy" is a four-color chart prepared by Tempil Corp. showing principal characteristics of steels (with carbon content ranging to 0.9 per cent) across the temperature range to 1900 F. Important working zones including preheating for welding, stress relieving, normalizing, annealing, carburizing and forging are shown.

432 Using Specialty Steels? — Offered by The Carpenter Steel Co., this 40 pp guide to selection of specialty steels contains information on tool and die steels; stainless steels; high temperature alloys; electronic; magnetic and electrical alloys; special purpose alloy steels: tubing and pipe, fine wire specialties. Includes tool steel selector chart.

Handling Equipment

433 Elevator Rope — Advantages of Macwhyte Wire Rope Co.'s elevator cables are detailed in 12-pp Catalog E-10-2, which also gives practical selection information, safety factors and tips on lubrication, inspection and maintenance. Secifically, this booklet tells how to determine lubrication of elevator rope, when to retire it, how to guard against unusual tension and how to socket elevator rope.

434 Wire Rope Slings — Detailed information on wire rope slings made by The Colorado Fuel and Iron Corp. is presented in this 84-pp product catalog. Each major type of sling is described, complete with illustrations and charts, and selection details and basic rules of hitching included.

435 How to Use Wire Rope — Comprehensive information on use and abuse of wire rope is presented in this pocket-size 92-pp manual offered by Macwhyte Wire Rope Co. Covers selection of wire rope, constructions, capacities, maintenance and lubrication, breaking-in of wire rope, approved methods of seizing wire rope, wire rope attachments.

436 Chain Slings, Connectors — Specifications and working load limits for alloy chain slings, rings, links and hooks are presented in this 16-pp product bulletin of Jones & Laughlin Steel Corp. Advantages and safety features are detailed, and data on use, maintenance included.

437 Industrial Truck Costs — A library of information on figuring industrial truck costs is presented in four bulletins — 62 pp in all. Includes cost histories and do-it-yourself formulas for calculation and comparison of all expenditures in owning, operating and maintaining trucks powered by electricity, gasoline, propane. Bulletins are offered by Exide Industrial Div., The Electric Storage Battery Co.

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Cooling Towers

438 Double-Flow Aquatower — Bulletin DFA15-60 describes The Marley Co.'s double-flow Aquatower designed to bridge the gap between standard double-flow Aquatowers and unlimited capacity industrial cooling towers. Specifications and engineering data included.

439 Cooling Tower Economies — Presented by Hamon, Inc. in this 12-pp bulletin is a discussion of economic comparisons on cooling towers for a utility. Compares natural draft and mechanical draft towers to various approaches and includes detailed cost comparison curves.

440 Cooling Towers — Performance details on cross-flow cooling towers of The Marley Co., are presented in this 20-pp illustrated Booklet CF-59. Discusses and illustrates through diagrams the cross-flow principle of water cooling; describes equipment, engineering and design features.

Construction Materials

441 For Roof, Wall Construction — Included in this literature file offered by Elwin G. Smith & Co., Inc. are product bulletins describing roof and wall construction materials. Bulletin 59C covers corrugated sheets; 59W, insulated walls and metal panels; 595, insulated sandwich curtain walls and roofs; Bulletin 60D, steel and aluminum roof deck; Bulletin 60F, high-strength permanent steel forms for concrete roof and floor slabs; and Bulletin 60R, conveyor hoods and curved corrugated sheets.

442 Safety Grating — Steel, aluminum and stainless steel safety grating for a variety of industrial applications is featured in illustrated 24-pp Catalog 5911 offered by The Globe Co. Shows typical installations, and includes engineering data for erection, load charts.

443 For Masonry Anchoring — Catalog 25 is a 48-pp pocket-sized handbook of anchoring and drilling devices produced by The Rawlplug Co., Inc. for fastening anything to masonry. Includes tables showing proper anchors for each type of fixture and material.

444 Aluminum for Architecture — Comprehensive information on aluminum alloys and surface finishes is provided by Olin Mathieson Chemical Corp. in this 20-pp. booklet. Contains guides to mechanical finishes, as well as descriptions of textures, bright or satin surfaces. Electrochemical and chemical finishes with recommended coating for varying architectural exposures are listed.

445 Watertight Masonry — Major considerations in designing tight masonry walls are covered by The Master Builders Co. in 6-pp Bulletin O.M.-8A. Discussed are mortar ingredients and proportioning, compatibility of brick and mortar, control of shrinkage and bleeding, separation cracks, effect of mechanical disturbances.

446 Masonry Fasteners — Fifty-pp pocket-size Catalog 160 of Diamond Expansion Bolt Co., Inc. lists anchors and fasteners for masonry and hollow walls. Covers machine screw anchors, lag screw expansion shields, machine bolt expansion shields, closed back machine bolt expansion shields, masonry drills, and a variety of anchors.

447 Water-tight Sealant — Physical properties and characteristics of A. C. Horn Companies' two-component synthetic rubber compound based on liquid polysulfide polymer for use in sealing joints where an absolutely water-tight seal is required are detailed in 16-pp Bulletin 6543. Lists advantages.

448 Grouting Methods — Effective methods for grouting the different basic types of heavy industrial equipment are explained with text and photos by The Master Builders Co. in 8-pp Bulletin EPMG-2A. Advantages of the pre-mixed grout are explained, and diagrams, charts and photos cover preparatory steps, forming, selecting materials, mixing, placing.

449 Handbook on Waterstops — In the 24-pp Kwik-Seal Waterstop Technical Manual of The Gates Rubber Co. is a wealth of practical information on waterstops and their use. Covers size and shapes of the waterstop, comparative data for rubber and plastic types.

Engineering Office Equipment

450 Reproduction Materials — Drawing and document reproduction material of Eastman Kodak Co. are featured in this 20-pp bulletin. A reproduction materials selection chart lists a variety of reproduction jobs, type of equipment to be used and materials needed.

451 Facts About Microfilm — "Let's Take a Positive Look at Microfilm" is an article reprint offered by Minnesota Mining and Mfg. Co. discussing merits of using microfilm as an active tool of business and industry. Applications shown.

452 Keep It Clean — How to clean and protect engineering drawings is told by Keuffel & Esser Co. in this 6-pp folder. Describes cleaning aides and protective spray, giving ordering information, prices.

453 Drafting Pencils — A variety of pencils and other items for drafting and reproduction work are featured in this 24-pp catalog released by J. S. Staedtler, Inc. Includes pencils for work on drafting film, for color coding on tracings, non-reproducing pencils for making temporary work notes on drawings.

454 Typing Engineering Symbols — A method of using an electric typewriter for quick, convenient typing of special symbols and equations needed in the field of engineering is the subject of this 8-pp bulletin of Sperry Rand Corp.'s Remington Rand Div. Describes variety of symbols which can be snapped on.

Water Management

455 Ultrapure Feedwater — Technical Reprint T-178 of Graver Water Conditioning Co. covers research problems relating to production and quality control of ultrapure feedwater for Eddystone Station. Presents pilot plant data on filtration and demineralization process for treating condensate. Specific plant-scale design features are described.

456 Feedwater Heaters — Open-Coil, tray-type feedwater heaters and purifiers of both deaerating and nondeaerating type are presented in 12-pp Bulletin 117A of Stickle Steam Specialties Co. Construction and operational features of the heaters are explained and illustrated, and available models are pictured.

457 Feedwater Heaters — Construction details and operating features of company's feedwater heaters are described in 16-pp Bulletin YHT 102. Illustrates and describes component features and includes photos of typical installations. Yuba Consolidated Industries Inc.

458 Sodium Zeolite Softeners — Described in 12-pp Bulletin 4520 by Cochrane Corp. is the sodium zeolite process

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of water softening. Includes information on selecting and sizing of equipment, automatic vs manual controls and calculations of softening capacity.

459 On Zeolite Softeners — "Care and Operation of Zeolite Softeners," covers bacterial fouling, deposits encountered and operational factors in relation to this equipment. Prepared by Betz Laboratories, Inc., it tells too, how exchange material should be handled to maintain maximum efficiency and longer equipment service.

When using the Reader Service Cards, please be sure to give your company name and job title, even if you want catalogs sent to your home. Manufacturers prefer to send literature to those who identify themselves

460 Boiler Feed Systems — Engineered condensation drainage and automatic boiler feed systems for industrial and heating requirements are described in 20-pp Catalog 55-D. Requirements of a boiler feed system and how individual components of the Fred H. Schaub Engineering Co. system are designed to meet these requirements are outlined, and specifications given.

461 Water Requirements Calculator — With this calculator you can quickly figure conversion of ppm water hardness to grains per gallon hardness, amount of exchange resin needed, brine and salt requirements, and brine tank size and operating brine level adjustments. Calculator, prepared by Morton Salt Co., can also be used in selecting tank size.

462 How Corrosion Attacks — In this data sheet, Betz Laboratories, Inc., explains how and why boiler, cooling and process water systems are constantly plagued by corrosion. Discusses such factors as pH, dissolved solids, temperature, flow rate, dissimilar metals, CO_2.

463 Ion-Exchange Controls — In Bulletin E-158, Illinois Water Treatment Co., describes automatic control systems for ion-exchange equipment. Standards designed to assure proper performance of control units are detailed, and various elements in the control cabinets, as well as the power-operated units, are described.

464 Corrosion Control — Methods used in steam-condensate systems for control of corrosion are described in Process Bulletin B-6 from Nalco Chemical Co. It covers use of filming corrosion inhibitors and neutralizing amines for low, medium and high makeup systems. Illustrations show how the inhibitors form a protective film and the amines neutralize CO_2.

465 Boiler Water Treatment — Chemical reduction of oxygen in boiler feedwater with hydrazine is the subject of 10-pp Bulletin BW of Fairmount Chemical Co., Inc. Economy and operation, handling of the Deoxy-Sol, methods of analysis and other details covered.

466 Steam System Treatment — In this bulletin on Coravol for prevention of corrosion Western Chemical Co. explains theory of corrosion, application of organic amines to steam systems (Coravol process) and presents case histories of use in different types of plants and industries.

467 Automatic Treatment Control — Methods for automatic control of water treatment plants are discussed in 8-pp Technical Reprint T-179 by Graver Water Conditioning Co. In two parts, Part I deals with control of demineralization plants and covers "stepless" regeneration, regeneration, quality control of effluent, conductivity pH control, automatic regeneration. Part II considers control of cold process softening and clarification units, hot process-hot zeolite systems and sodium zeolite systems.

468 pH and Chlorine Control — The 14th edition of W. A. Taylor Co.'s handbook "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrate, sulfate, hardness and other tests. Slide comparators and test kits are illustrated. Methods are also outlined for quantitative analyses. Available to qualified power engineers, please state your job title.

469 Treatment Instrumentation — Provided in 30-pp Booklet D97-2 of Minneapolis-Honeywell Regulator Co. is a compilation of article reprints on instrumentation for treatment of water and sewage. What instruments are used, how they are used and their functions in controllin automatically the many variables encoun tered in the treatment process are covered

470 Consulting Service — Advantages of Dearborn Chemical Co.'s consulting service are detailed in 8-pp Bulletin 5006-A. How the service is qualified to solve problems concerning scale and corrosion control in boilers, cooling systems, and process waters is discussed.

471 Industrial Water Service — The importance of water to industry and advantages of an industrial water consulting service are detailed by Hall Laboratories in this 22-pp bulletin. Specific examples of benefits offered typical users of the consulting system are given.

472 Water, Sewage Treating — Water, sewage and industrial waste treatment equipment of Link-Belt Co. is described in 20-pp Book 2617. Illustrates equipment and shows flow diagrams of installations in typical water, sewage, and waste treatment plants.

473 Putting Effluent to Work — Use of sewage plant effluent for boiler and cooling purposes is discussed by Betz Laboratories, Inc. in Technical Paper 138. Tells how effluent can be used in recirculating cooling systems and as boiler makeup if treated to avoid organic growths, deposits and corrosion in cooling systems and foaming, carryover and ammonia corrosion in boiler and steam systems.

Mechanical Power Transmission

474 Variable Speed Drives — Designated M-592, this 96-pp catalog explains through copy, photos and drawings the wide assortment of styles, modifications and accessories available in mechanical variable-speed Motodrives offered by Reeves Pulley Div., Reliance Electric and Engineering Co. Includes construction features, speed and rating tables.

475 Fluid Drives — Well illustrated 20-pp Bulletin A-719, on American-Standard's Class 4 adjustable speed Gyrol fluid drives, discusses principles of operation and shows typical applications. Horsepower and inertia starting capacity curves are provided. Components of the unit are illustrated. Selection guide charts are presented for both variable torque and constant torque applications.

476 Torque Manual — This 32-pp catalog is a recent revision of P. A. Sturtevant Co.'s popular torque manual. Includes application illustrations, bolt charts discussions on assembly characteristics, instructions for torque wrench testing, pictures of modified and special torque wrenches, formulas and illustrated explanations for using adapters, attachments and extensions.

477 Flexible Couplings — Comprehensive selection data on flexible couplings is presented by Thomas Flexible Coupling Co. in 58-pp Engineering Catalog 60. Misalignment is described and basic coupling arrangements and load classifications are included, along with illustrations.

478 Eddy Current Coupling — Presented in 12-pp Bulletin GEA-6885 is extensive information on General Electric Co.'s Kinatrol line of eddy current coupling adjustable speed drives for 5 to 100 hp. Describes operating principle and contains data on torque capabilities, regulation and operation of entire package drive, cross-sections, dimension charts, ratings.

479 Coupling Data — An integrated selection of product bulletins and data on couplings of Koppers Co., Inc., for a variety of industrial applications is presented in this handy ringbound notebook. The notebook contains sections on product literature, engineering data, instruction sheets, application data, and price lists. To all of these sections, additional material can be added as it becomes available.

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Maintenance Coatings and Cleaners

480 Coal-Tar Coatings — Bulletin CAC-11-958, 14-pp, describes coal-tar protective coatings of Plastics & Coal Chemicals Div., Allied Chemical Corp. Primarily moisture barriers and impervious corrosion proofers, these coatings are particularly suitable for buried or immersed steel and concrete structures. Booklet lists specifications, resistance properties and typical industrial applications for expanded cold-applied coal-tar coatings.

481 Corrosion Resistant Coatings — Latest developments in corrosion resistant coatings, treatments for floors, and coatings and waterproofing for masonry are described in 72-pp Form 990 of Truscon Laboratories Div., Devoe & Raynolds Co., Inc. Presents information on maintenance products available for interiors, floor coatings, exteriors, new construction.

482 Protection Against Rust — This 38-pp treatise (Form 259) on rust and corrosion control by protective coatings shows actual color standards of Rust-Oleum Corp.'s primers and top coatings. Covering water resistant, heat resistant floor coatings, heavy-duty chemical resistant coatings, galvanized metal coatings, wire fence roller coatings, and quick-dry coatings. Bulletin contains full-color application photos and 110 color chips, and technical section giving data on surface preparation types of application techniques.

483 Efflorescence, Chalking — Causes of efflorescence and early chalking on painted masonry surfaces, and ways to overcome and prevent such deterioration are explained by Rohm & Haas Co. in this 48-pp booklet. Discusses paint formulation and compares four major types of emulsion vehicles for resistance to alkali, moisture, heat, and ultra-violet light. Also covers film swelling, film coalescence, paint stability in presence of soluble salts.

484 Aluminum Paints in Color — Protective and decorative advantages of painting with aluminum in color are discussed by Aluminum Co. of America in Form 30-11451. Illustrated in full color, shows examples of use of this metal-bright paint on industrial structures.

485 Painting Galvanized Steel — Effective techniques for painting galvanized steel sheets, are explained in this 16-pp booklet, produced jointly by the American Iron and Steel Institute, the American Zinc Institute, and the National Paint, Varnish and Lacquer Ass'n. Discusses main reasons for this painting: appearance, heat reflection, longer service.

486 Paint Economy — Factors to consider in selecting paints are detailed by Barreled Sunlight Paint Co. in this sixth edition of "Engineered Color," a 20-pp specifications catalog. Covers proper use of paint and color, requirements of various surfaces, color and the safety program. Describes interior and exterior primers and finishes, varnishes and floor sealers, and includes color chips.

487 Masonry Treatments — Water-proofing, protective and corrective treatments for masonry are described by Standard Dry Wall Products, Inc. in 22-pp Circular 17. Discusses products and their applications, includes photos of typical applications.

488 For Chemical Cleaning — Technical Bulletin 102, about 16-pp, presents application and other information on products of Chas. Pfizer & Co., Inc. for chemical cleaning. These include formulas for power plant cleaning, stainless steel cleaning, aluminum and aluminum alloy cleaning, alkaline derusting and paint stripping, general cleaning, others.

Hose and Fittings

489 Hose, Fittings, Couplings — Industrial Catalog 204, about 40-pp, contains information on hose, fittings, self-seal couplings and related products of Aeroquip Corp. Provides specifications on products for general industrial applications, power plants; others. A hose selector chart lists applications and fluids for which specific hose types are recommended.

490 Hose and Fittings — Comprehensive data on The Weatherhead Co.'s hose and hose assemblies, brass and steel tube fittings, hose and tube working tools, stock cabinets, hose racks and other specialty products are presented in 128-pp Catalog C-300. Profusely illustrated, it contains hose selector chart, assembly data chart, detailed specifications, application and installation instruction. Available to qualified power engineers, please state your title when requesting this catalog.

Other Equipment

491 Engineering Data Tables — Bulletin 5311, released by Leslie Co., contains 12 pp of engineering data tables. Included are formulas for valve, sizing, properties of saturated steam, steam flow in pipes, steam pressure drop determination, oil flow and viscosity data, properties of gases and liquids, piping data and fixture water flow, conversion factors. Also provided is handy chart covering selection of piping and valve materials.

492 Tube Fittings — This 118-pp catalog contains comprehensive information on company's tube fittings, including the O-ring seal fittings. Each specification table is coupled with a large, close to actual size cutaway drawing with all dimensions on illustration keyed to specifications and dimensions table. It is available from The Lenz Co. to qualified engineers. Please state your title.

493 Cathodic Protection — Booklet describes corrosion control for buried or submerged piping, tanks, ships and similar structures. The company's consulting services, field surveys, design, installation and materials as well as general cathodic protection procedures are discussed in detail by Harco Corp.

494 Why Coil Freeze-Ups. — Technical Bulletin T-503 of Sarco Co., Inc. explains why non-freeze air heating coils freeze. This bulletin discusses the factors leading to freeze-ups, provides a chart for determining the freezing danger point, and offers some practical hook-ups to overcome freezing conditions.

495 Delivery Truck Bodies — Illustrated and described in this ring-bound catalog is the Boyertown Body & Equipment Co. line of delivery truck bodies. Construction and design features are detailed and complete specifications are included, along with list of typical applications in commercial, industrial and utilities fields.

496 Crushing Handbook — This 40-pp Handbook of Crushing by Pennsylvania Crusher Div., Bath Iron Works Corp., covers the subject of mechanical size reduction, describing various reduction methods — impact, attrition, shear and pressure — and many kinds of crushing equipment. Illustrated with diagrams and charts, it contains data on closed circuit crushing systems, factors in selecting crushing methods.

497 Corrision Data Charts — Corrosive effects of almost 400 different materials on 16 types of metals are shown in corrosion data charts contained in Technical Service Bulletin 101 issued by Nooter Corp. Charts indicate corrosion resistance of metals to various concentrations of chemical salts and acids, as well as common materials such as water, glue, fruit juices, salt, turpentine, others.

498 94 Chemicals Reviewed — Organic and inorganic chemicals — 94 in all — produced by Hooker Chemical Corp. are reviewed in this 16-pp Bulletin 100-D. Gives factual information on 88 commercially produced products, six development ones, including 20 recently developed chemicals. Covers acids, alkalies, the elements chlorine and phosphorous, metallic salts, phosphorous and sulfur compounds, chlorides, chlorobenzenes, others.

499 Scale Model Components — Vessels, heat exchangers and pumps of molded expandable polystyrene — model equipment which can be worked with knife or hand saw and can be sanded, glued, pinned or screwed — are featured in this 8-pp bulletin of Industrial Models, Inc.

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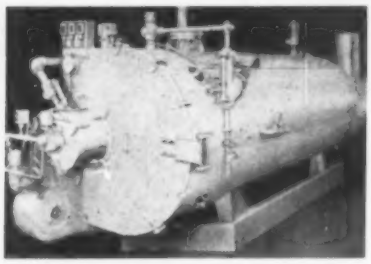
Equipment News

Described on these pages are new and improved products. Use Reader Service Cards on pages 87–88 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—Automatic firetube boiler with side-located furnace

Burner and furnace are on the left side at the horizontal center of the Powermaster Positive Flow (Model PF). It is of three-pass design with no tubes directly above or below, avoiding any impediment to natural circulation flow. According to manufacturer, Orr & Sembower, Inc., the side located furnace provides the most efficient circulation of water; it permits boiler feed injection and natural thermal circulation to augment each other, providing maximum



water circulating rate and most efficient form of heat transfer — counterflow. Circulation pattern is comparable to that in a watertube boiler. It develops as relatively cool water is directed down through the second pass and around furnace. The side located furnace also eliminates danger of heat damage due to stagnant water and sludge, says company; and facilitates inspection of fireside and waterside surfaces.

Also announced for this boiler are quiet operation and easy accessibility provided by a hinged front cover with quick-opening fasteners and a divided rear cover with each section hinged. Dryback construction is standard; wetback, optional. Five sizes from 50 to 100 bhp will be available — oil-, gas- or combination fired. Hot water and steam atomization models planned.

2—Fuel economizer reduces costs and minimizes smoke

Sayvoil is a burner mounted fuel economizer which, according to manufacturer, Farris Combustion Controls Corp., can reduce fuel costs up to 25 per cent and practically eliminate smoke. It injects an envelope of preheated air (up to 875 F) around atomized oil burner flame to produce more rapid combustion and more complete burning of fuel.

3—Centrifugal pumps feature vertical base mounting

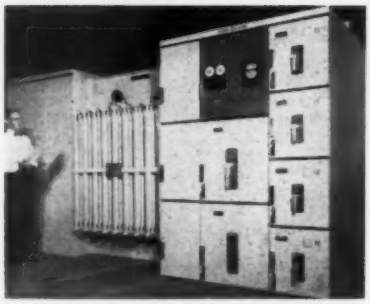
Space requirements are minimized with vertical base mounting design of Type AJ Two-Stage Split Case Pumps manufactured by Aurora Pump Div., The New York Air Brake Co. Case is split parallel with impeller shaft, and bearing housing supports, suction and discharge flanges are integral with vertical base section of case, allowing removal of rotating element without disturbing suction or discharge connections. With capacities to 1400 gpm and heads to 425 ft, pumps can be used for industrial water services, municipal water services, pressure booster service, cooling towers, fuel service, circulation and boiler feed.

4—One-time fuse has long time delay, low watt loss

Advantages announced for this one-time fuse by The Chase-Shawmut Co. include long time delay, low watt loss and predictable performance. It saves power, company says, by running 38 per cent cooler; meets safety requirements of a-c d-c circuits, has silver-plated contacts and is competitively priced.

5—Corrosion inhibitor for the recirculating systems

Nalco Chemical Co. announces a method for controlling corrosion in recirculating cooling water systems. It is based on initial preparation and protection of metal surfaces of new or freshly acidized cooling water equipment. Preparation consists of removal of materials that interfere with corrosion inhibitor film formation, such as oils, greases, rust, with a chemical known as Nalprep. It acts to prevent clean activated metal from reacting with anything but the filming inhibitor present, and provides the initial protective film. Equipment will then be maintained in protected state, company says, with usually employed corrosion inhibitors during normal operation.



6—Unit substation with improved low voltage switchgear

For applications using 600 v a-c and below, this custom-line load center unit substation is announced by General Electric Co. as providing greater service reliability, convenience and operator safety. Its drawout switch-gear incorporates compartmentation of breakers, bus and cable termination, providing isolation against spread of short circuits. Ample cable space is provided, and run back conductors eliminate interleaving cable between phases, allowing straight runs to load studs. Isolation of incoming conductors from main bus reduces hazard of fault communication between main bus and incoming line, and permits isolation by main secondary breaker should a main bus fault occur.

Bus construction of the substations combines advantages of welded aluminum conductors and silver-plated copper terminations. All control devices and instruments, including fuses in pull-out dead front fuse holders, are accessible from front. Breakers can be racked to "connected," "test," or "disconnect" position, with compartment door closed. For increased safety, interlocks act to prevent inserting or withdrawing the breaker when closed.

7—Thread loosener sprays on to free rusted, seized parts

Mechanics Thread Loosener (Easy-Spray) comes in 16 oz. aerosol containers. Company says it penetrates rust and corrosion, freeing tight or rusted pins, linkage, hinges, nuts, bolts, valves and other seized parts. The formulation is described as a non-gumming lubricant which eliminates rust and corrosion, increases parts life and minimizes wear. A free trial can is available from The Whitmore Mfg. Co.

8—Power capacitors offer space savings advantages, unusually cool operation

Introduced by Federal Pacific Electric Co. are a Cornell-Dubilier 50-kvar power capacitor (at left in photo) and a 100-kvar "Slim-Jim" model right), rated 2400 through 7960 v, 60 cycle, single phase with single or double bushings. They are for substation stack racks and pole-mounted racks on utility transformers. The 50-kvar capacitor weighs 92 lb, has a case height of 22½ in. The 100-kvar capacitor weighs 175 lb; its case height is 41½ in. It's engineered for space saving — with same width and depth as 50-kvar unit (13½ by 4½ in.) and only 19 in. higher, it can provide twice the kvar per square foot as a rack with 50-kvar units. Also 12 "Slim-Jims" — giving a total capacity of 1200 kvar — can be accommodated in an in-line pole-mounted rack less than 8 ft long.

Another feature claimed for the 100-kvar capacitor is exceptionally cool operation, due to the fact that it has almost the same surface area as two 50-kvar units. This results in easy distribution of heat with maintenance at low case temperatures.

Equipment News continued on page 106

EFFICIENCY 84.18%

Wiley & Wilson, Consulting Engineers
J. L. Hamilton Engineering Co., Installing Contractor

JOB: Supplying steam for space heat, hot water service, hospital needs, and refrigeration at Univ. of Virginia. Campus includes 100 buildings (approx.) plus 600-bed hospital.

STEAM GENERATORS: Two from Union carry the entire load. Recently installed, the one above is a Type VO two-drum unit (72,000 lbs./hr. continuous, 475 psi). Spreader stoker fired. Air heater supplied for heat recovery.

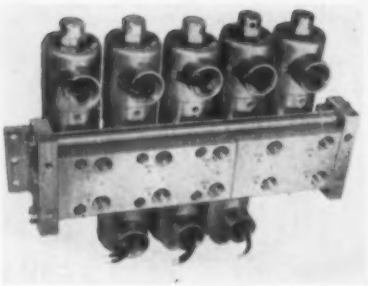
PERFORMANCE: One month's operating log for illustrated unit shows: 33,539,300 lbs. of steam generated. 1,382.5 tons of 14,243 BTU coal consumed. Average evaporation of 12.1 lbs. Max. 8-hr. load of 65,000 lbs. Max. 24-hr. load of 59,000 lbs. *Average efficiency for month — 84.18%.*

MORE FACTS: Many types and sizes of Union Steam Generators are covered in illustrated Bulletin GB-959. Write: Union Iron Works, Erie, Pa., Division of Riley Stoker Corp.

UNION

steam generators

For more data circle 534 on Post Card



9—Subplates permit many valves to mount as single units

Pneumatic and hydraulic control systems can include multi-valve stations mounted as single integrated units by means of Co-Ordinates announced by Versa Products Co., Inc. Unlimited manifold mounting of company's Series A solenoid valves in one location is claimed possible by using modular design technique of unit-by-unit expansion. Two-place and three-place mountings are basic units for building-up multi-valve stations in an unlimited series. Additional blocks can be added at any time. Principal advantage claimed is increased capacity in minimum space.

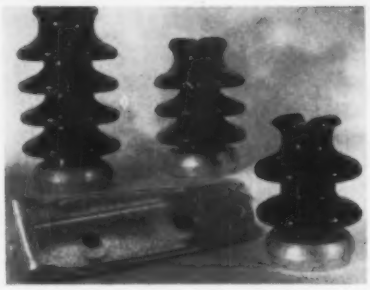
10—Water chiller protected by overtemperature control

Compressor motors on PKB Chillers, introduced by Westinghouse Electric Corp., are protected by a Guardistor overtemperature control circuit against overheating from excessively high or low voltage, single phasing, or loss of Freon from compressor. In addition, quick trip overload heaters are included for 6-sec kick out on any overload condition, company says, even on cold start. Line includes eight sizes rated 20 to 100 tons. Larger units, rated 60, 80 and 100 tons, have twin compressors that provide step starting, demand charge savings during mild seasons, and protection against complete loss of service in event of failure.

11—Variable speed belts in types, sizes for industrial use

Top widths of standard sizes of these belts range from ⅞ to 3 in., and nominal overall lengths from 26.4 to 170 in. In-

troduced by Lovejoy Flexible Coupling Co., the belts are fiber-reinforced synthetic rubber, designed to withstand the intense squeezing action of pulley sheave walls and provide smooth transmission at full power capacity. Length stability — in service or in storage — is attributed to "stretch resistant" properties of reinforcing cords. Uniform notching on the underside is claimed to provide flexibility without excessive strain or distortion on small pulley applications.



12—Distribution post rated at 15 kv, of solid porcelain

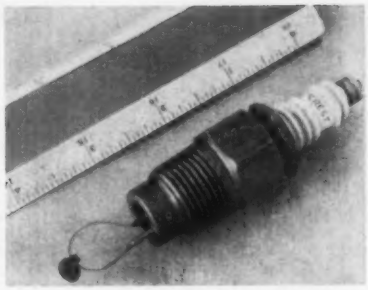
The Lapp Insulator Co., Inc. announces a distribution post insulator rated at 15 kv, matching in characteristics and appearance the 20-kv and 27-kv posts introduced earlier. The 15-kv unit, Catalog 4315A, is a solid, vacuum process porcelain post cemented into a galvanized steel base and mounted with standard line post studs. It is described as puncture proof, free from radio and television interference without coating, treatment or attachment, and mechanically strong.

13—Numerical readout pinpoints gas burner failures

The Telefier has been developed by Protection Controls, Inc., to provide instant numerical indication showing exact burner position when a flame failure or other fault occurs in multi-burner gas-operated heating systems. The direct-reading flame-fault indicator is designed to eliminate checkout of each burner and various trouble-shooting operations. Manufacturer explains that if a flame goes out, or flame rod electrode becomes grounded, the Telefier instantaneously scans all burner circuits to pinpoint the trouble spot; then it "telegraphs" correct signal to numerical readout indicator. Although intended for use with company's own Portectofier Combustion Safeguard, the Telefier also operates with other multi-burner combustion controls. Indicator lights can be arranged on panel in same physical position and numerical sequence as combustion safeguards. Standard units serve up to 23 burners. Enclosed or open-type units for panel mounting are available — they cost around $180.

14—Automatic charger for the stationary type batteries

According to Hughes Electronics Co., Silicon Controlled (S. C. R.) Full Float Automatic Battery Chargers offer improved d-c voltage regulation (less than ½ of 1 per cent) for input line changes of ±10 per cent and a frequency change of ±5 per cent. The S.C.R. replaces magnetic amplifier previously used, with savings in weight and size at no increase in cost. Current limiting is provided in both "float" and "equalize" positions for overload protection to charger and battery. Units are available from 24-120 v d-c in capacities from 1-125 amp. Company says S.C.R. chargers achieve higher operating efficiency, more stability, and unlimited life, since the S.C.R. and other semiconductors do not age, and the silicon power rectifiers and S.C.R. are hermetically sealed against moisture, dust, etc. Modular construction is used. Bulletin SCR-B5 gives details.



15—Oxygen detector probe for use in closed water systems

Model 1060 Oxygen Detector Probe, designed by Crest Instruments for use in closed anaerobic water systems, is said to combine low cost, rapid response and easy installation with exceptional reliability. It has been found promising in secondary recovery systems and in monitoring O_2 in boiler feed water, according to company. Operation is based on principle of a differential oxygen cell. In presence of low concentrations of O_2 the exposed strip becomes cathodic. Covered section becomes anodic and preferential corrosion proceeds underneath the Neoprene band. Installation is accomplished with any ½ in. IPS fitting.

16—Calculator aids in plotting frequency response curves

The Frequency Response Calculator of Hagan Chemicals & Controls, Inc., is a pocket-size tool designed to eliminate need for slide rule calculations or complex chart references when plotting a

frequency response curve as a means of evaluating an amplifier, controller, transducer, power positioner or other control device. With it, you can convert input-output relation of a component into the decibels of attenuation or gain occurring at a given frequency, and thus determine one point on the frequency response characteristic curve. Also, by taking any point off a frequency response curve, plotted in frequency versus gain in decibels, you can read the ratio of input to output.

17—Heat exchangers use standard assembly components

The C-200 line of straight tube, fixed tubesheet heat exchangers is designed by American-Standard Industrial Div. to adapt standard components to custom-built assemblies for specific chemical and industrial processing requirements. "Selective assembly" method is said to result in delivery time and cost reductions, and provide wide choice of component variation to meet operational and environmental specifications. Exchangers will handle any combination of liquids and gases, company says, and may be used as heaters, coolers, condensers or vaporizers. They are available in shell sizes from 8 through 42 in. with any

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88,000 leak-tight tube ends rolled with WILSON Torq-Air-Matics

For every tube . . . every size . . . every type of job, Wilson Torq-Air-Matic Automatic Expander Drives are fast, accurate, easy to use. In fact, Wilson's wide range line offers an economical answer to every tube maintenance problem. For example, Wilson has powerful tube cleaners, rugged, economical tube cutters, plastic tube pilots, right angle worm gear drives, tube knockout tools—all these and many others are ready to meet your tube maintenance needs. You'll find it pays to WILSONIZE TO ECONOMIZE.

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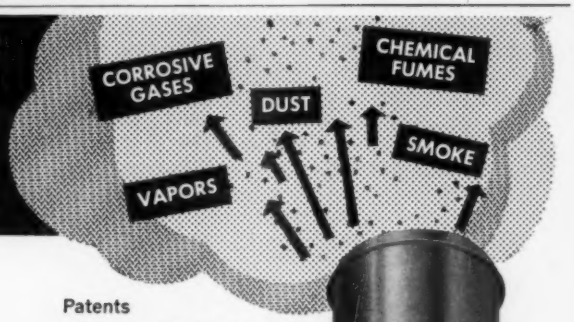
PERFECT DRAFT-CONTROL BY **Quickdraft**



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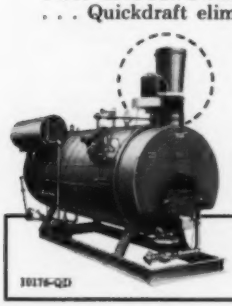
FOR INDUSTRY . . . Now you can boost the combustion efficiency of your boilers, regardless of the fuel you use. Quickdraft power-draft units provide instant controlled draft and completely remove all combustion, corrosive and noxious fumes at high temperature without passing them through the blower and motor. Maintenance costs are drastically reduced. Specify a Quickdraft unit to meet your particular requirements from a wide selection of various sizes.

FOR INSTITUTIONAL AND COMMERCIAL BUILDINGS . . . Quickdraft eliminates costly, tall and unsightly stacks. Vent incinerators, heating plants and water heaters at roof level . . . safely and efficiently.

Patents
U.S. 2,722,372 and 2,855,874
British 802,920
Canadian 593,817
Other patents pending



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All Quickdraft units are available in standard acid resisting vitreous enamel, 316 stainless steel, carpenter 20 rigid plastics (P.V.C), and with plastic or Fiberglas coatings.

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MANUFACTURERS OF ALL TYPES OF MATERIAL HANDLING UNITS WITH EXTREMELY HIGH VELOCITIES.

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HOW MUCH DOES *UNPLANNED* DOWNTIME COST IN YOUR PLANT? $1000...$5000...$10,000 an hour?

In many cases the costs in spoiled processes and lost production amount to several times those figures.

You Can't Bargain With Trouble!

Only preventive measures will reduce it. Periodic inspection of important electrical equipment with a Megger® Insulation Tester, and the records of these tests, will provide the data you need to anticipate trouble—to prevent production line interruptions.

Buy Prevention—Improve Profits

Megger "instruments for prevention" cost only a small fraction of the price of equipment failure, work spoilage and the many other wastes that help to destroy the profits picture.

An investment in a Megger Insulation Tester is like the premium on an accident policy except that the Megger Tester can be the means of preventing the accident.

Preventive Maintenance Is Productive

Any production department will thank and even praise a *preventive* maintenance department for its ability to spot trouble before it happens.

We have the answers—want them?

Write for Electrical Preventive Maintenance material—File 21-PE

MEG® TYPE OF MEGGER INSULATION RESISTANCE TESTER—Available hand-operated, rectifier operated, or with a separate rectifier. Ranges up to 2000 megohms and 1000 volts d-c in all three models.
BULLETIN 21-45-PE

MEGGER GROUND TESTER measures the resistance of earth to ground connections simply, easily and accurately, and thereby helps to determine whether such connections will perform the services for which they were designed and installed.
BULLETIN 25-PE

B1014R-2

BIDDLE INSTRUMENTS

JAMES G. BIDDLE CO.

Electrical & Speed Measuring Instruments

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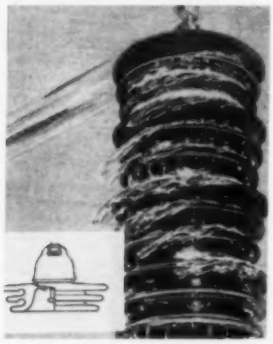
For more data circle 537 on Post Card

practical tube length. Features contributing to versatility include choice of nozzle size, baffle spacing, horizontal or vertical mounting.

18—Fog type insulator reduces maintenance problems

Delta-Star Electric Div. of H. K. Porter Co., Inc. announces a fog type insulator, with 50 per cent greater leakage distance than conventional units, for use where



heavy fog or industrial contamination presents a maintenance problem. It also offers improved ability to prevent flashovers, company says. Contours and undercut in discs, or "petticoats," are designed to minimize possibility of surrounding dense fog forming path of conductivity between line and post. Insulators come in ball and socket or clevis and pin types.

19—Surface finish provides anti-slip protection

Ruffin is announced by Custom Abrasive Products Co. for use on floors, decks, ramps, docks, elevated walkways and stair treads. A brush-on or roll-on finish based on Thiokol polysulfide modified epoxy on which fine or coarse abrasive grains are sprinkled, it adheres to wood, metal, cement and floor tile, company says. It is suggested for surfaces that are slick or exposed to weather.

20—Sequence control for multiple boiler installations

Master Monitor is a complete modulating sequence control in a single enclosure, designed by Cleveland Controls, Inc, for automatically operating a bank of boilers, compressors or other units, so that only required number are called on to meet demand load. It cuts individual units in and out of operation in response to pre-determined pressure or temperature variations — or to any other signal.

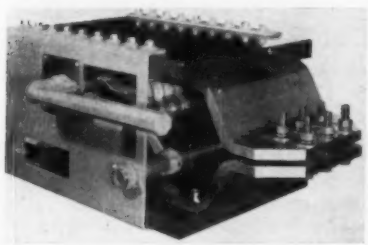
It is adaptable to modulating, high-low or on-off systems, can be applied to existing installations as well as new construction. Models are available for sequencing up to 10 units.

21—Test unit for checking iron content in water

An iron test unit simple enough for use by inexperienced personnel to check the presence and amount of iron in water is available from Hagan Chemicals & Controls, Inc. KO082 involves only addition of two reagents to water sample and comparison with color slides containing nine standards in sealed glass vials representing iron concentrations from zero to 1 ppm. Reagents and equipment to perform 100 tests are included in the unit. Bulletin HSP-933 gives details.

22—Disconnect switch for heavy industrial applications

Delta-Star Electric Div., H. K. Porter Co., Inc., announces this low voltage, high current disconnect switch for steel mill and other heavy industrial use. For



750-v operation, the copper "wedge" type switch comes in a standard 5000-amp unit or in multiples of 5000 amp for gang operated applications. Design features reported include self-aligning copper contact wedges offering good wiping action both closing and opening, nonfatiguing back-up springs, silvered contact surfaces. The switch is compact and can be fitted with such devices as auxiliary switches for indicating lights.

Reader Service Cards on pages 87–88 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

23—Submersible a-c motors for close-coupling to pumps

Introduced by Reliance Electric and Engineering Co., these pressure-proof a-c motors are designed for close-coupling to centrifugal pumps operating in any depth of water, oil or liquid chemicals. Motors come in sizes from ½ through 40 hp for operation from polyphase sources and from ¾ through 5 hp for single-phase connection. They are rated at 55 C temperature rise for 30-min duty in 40 C air and for continuous duty in 40 C liquids. The heavy one-piece ribbed housing is leakproof, company states, and both cast-iron motor frame and mounting base are impervious to corrosion. Of Liqui-Seal construction,

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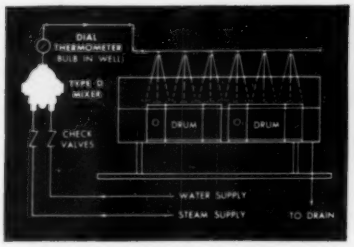
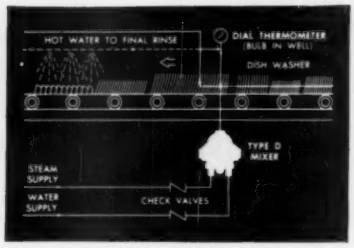
How To Maintain Uniform Process Hot Water Temperature





Schematics above show the function of Powers Type D Mixer in standard systems for maintaining uniform process hot water temperature where it is not practical to install or use a steam heated storage tank. These drawings are taken from the Powers *Engineer's Manual, Steam-Water Service* which is free to you for the asking. Each drawing is supplemented with detailed engineering information about the controls used. Everyone concerned with the installation and/or operation of steam-water service will find these diagrams a helpful guide in laying out a new system or updating an existing one. Other sections offer similar easy-to-follow diagrams and concise details on the following:

- Domestic Hot Water
- Hot Water Storage Heaters
- Instantaneous Heat Exchangers
- Heat Exchangers For Cooling
- Fuel Oil Heaters
- Pressure Reducing
- Jacket Water Cooling
- Two-Temperature Hot Water Systems

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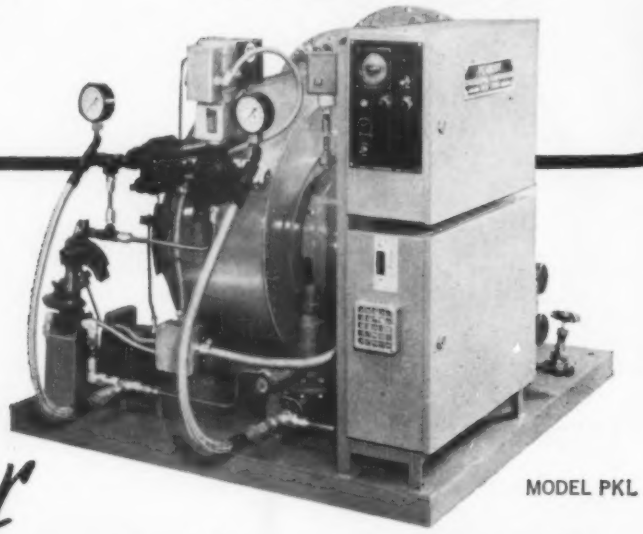
FIELD-PROVEN

NEW PEABODY PKS and PKL

COMBINATION GAS AND OIL BURNERS



MODEL PKL

for

...Pressurized Furnace Package Boilers
...Conversion of Coal-Fired Boilers
...Process Furnaces

These *all new* automatic fuel burners, with completely interlocked sequence and safety circuits and unified fuel-air ratio control provide maximum security before start-up, during operation and after shutdown. They —

- Recirculate hot fuel oil
- Test fuel oil temperature
- Test fuel pressure
- Purge furnace with forced draft fan
- Prove ignition...all before start-up!
- Ignite with gas-electric ignition
- Light off at low fire
- Operate quietly
- Burn gas or oil (No. 2 through No. 6 oil)
- Follow load demand
- Maintain efficient combustion at all loads
- Change over rapidly from one fuel to the other
- Shut down if load ceases
- Shut down in ONE Second and lock out on flame failure
- Purge furnace with forced draft fan after shutdown
- Relight automatically when load resumes or relight manually after flame failure but only after satisfying all safety requirements

These factory assembled and tested PK burners have no atomizer moving parts to get out of order. Their unique safety and control features provide the optimum in safe, dependable, efficient, clean, quiet operation — day in and day out. Write today for new Bulletin 431

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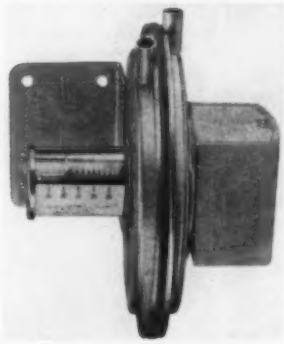
the motors are oil-filled and need no additional lubrication. Heart of the construction is a Neoprene diaphragm with built-in O-ring, which encircles the motor base to disperse pressure differences over a large area. If internal and external pressures differ, due to heat or depth of immersion, the diaphragm flexes slightly to neutralize the pressure, thereby relieving pressure build-up around the O-ring and shaft seal.

24—Differential pressure switch features low settings

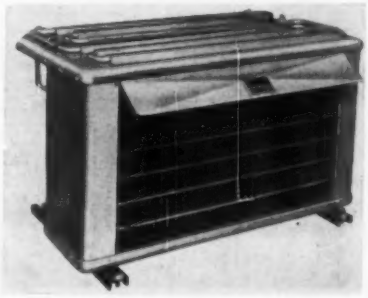
Produced by F. W. Dwyer Mfg. Co., the 1630 Series Differential Pressure Switch is designed for reliable control in pressure ranges too low for conventional switches. Dead band is unusually small. One model, for example, may be set to open a circuit on a pressure differential



increase of only 0.05 in. of water and to close on a decrease of 0.03 in. Repetitive accuracy is reported as within 1 per cent, with virtually no error due to drift or hysteresis. The switch is suitable for liquid level controls, induced draft interlocks, exhaust hoods, dust collection systems and air filters. Pressure set point is visible on a scale marked in inches of water. Calibration adjustments may be sealed or safety wired. Switches with weather-proof or explosion-proof housings, special diaphragms for extreme low temperatures or "fail safe" pilot lights are also available. Bulletin E-30 gives details.

25—Heat cycle defrost system works automatically

HC Heat Cycle Defrost Units of Dunham-Bush, Inc., incorporate an automatic, time initiated-temperature terminated defrost system. Inner fin evaporator is combined with heat cycle exchanger to produce what is described as a fast, safe, and efficient defrost system. Superheated discharge gas from compressor passes through one side of heat cycle exchanger, enters inner tube



defrost circuit of evaporator and defrosts coil from inside. Sub-cooled liquid refrigerant returning from inner tube circuit of evaporator passes through other side of heat cycle exchanger where it is boiled off before returning to compressor. When defrosting is complete, a temperature sensitive switch terminates defrost cycle and returns to normal refrigeration cycle.

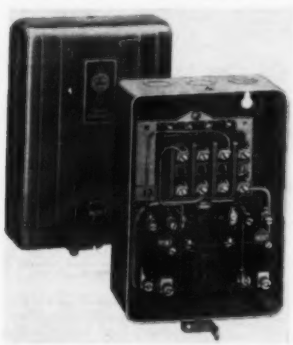
26—Breakdown testers for high voltage equipment

A-C Mobile Hypot Breakdown Testers are offered for proof tests, trouble shooting and preventive maintenance programs of industrial electrical distribution systems and equipment. They are designed by Associated Research, Inc., to

test insulation breakdown in large motors and generators, transformers, power transmission cables, switchgear, bushings, and samples of insulating materials. Output is continuously variable from zero to maximum, through a 10-ft shielded cable. A 4½-in. rectifier type kilovoltmeter is connected directly across high voltage output to assure accurate measurements. Cabinet has semi-pneumatic tires and push-handle.

27—Starter, contactors in Size 00 for motors to 2 hp

Bulletin 6013 Type CY Size 00 Starter and Bulletin 7707 Type CY Size 00 Contactor are designed by The Clark Controller Co. for non-reversing, full-

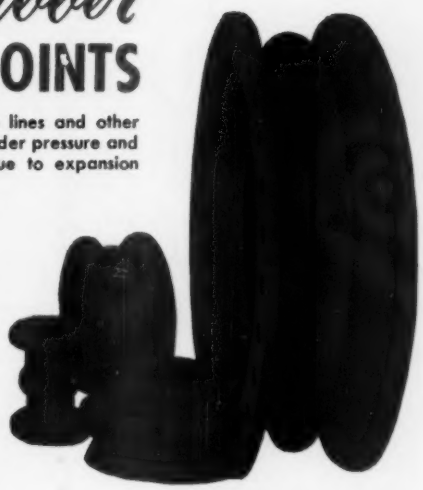


voltage starting of ⅛-to 2-hp squirrel cage motors. The same unit can be used on single-phase or three-phase motors operating on 110-to 600-v power, and 25-to 60-cycle frequencies. Starters have melting-alloy, thermal-overload relays. On single phase, only one overload is required. The units are available as open type or in NEMA Type 1 general pur-

Two Practical Products of **GOODALL** *Quality and Craftsmanship . . .*

FOR RELIABLE, LOW-COST SERVICE

GOODALL *Rubber* **EXPANSION JOINTS**



Flexible, durable connections for pipe lines and other equipment handling fluids and gases under pressure and vacuum, to prevent excess stresses due to expansion and contraction; to counteract vibration; and to insulate against undesirable sound. Can also be designed to overcome misalignment.

EASIER TO INSTALL—on new equipment or as replacements. Light in weight, with short face-to-face dimensions. Metal retaining rings quickly aligned and bolted. No gaskets required.

LONGER SERVICE LIFE—no embrittlement or corrosion. High resistance to abrasive wear.

STYLES, SIZES AND PRESSURES TO MEET ALL REQUIREMENTS

GOODALL *Rubber* **ABSORBER UNITS**

Easily installed units engineered to "absorb" vibration, water hammer and other undesirable sound, or where lines are subject to corrosion, abrasion or electrolysis. Light in weight yet exceptionally tough and durable. Installed with two male couplings or molded rubber flanged ends with split steel flanges. Hose can be furnished plain or with built-in wire reinforcement, for suction or discharge.

SPECIFICATIONS: Acid- and abrasive-resistant rubber tube; abrasion- and weather-resistant cover; sizes 1½" through 12" I.D., in lengths of 12", 18", 24", 36" and 48".

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pose enclosures in three forms: Form MA for separate push button operation; Form MB for "hand-off-automatic" selector switch; and Form MC with start-stop push button.

28—Metal hose offers improved fatigue life, flexibility

Hi-Flex is the trade name of Flexonics Corp.'s metal hose line incorporating improvements in flexibility, pressure ratings, fatigue life and maintenance. Designed for the "more exacting applications" in industry in hydraulic, pneumatic and cryogenic lines, it will have application also in utility piping. Hi-Flex comes in sizes from ¼ to 1-¼ in., helically convoluted, braided or unbraided. Because of single longitudinal weld and smooth helical convolutions, hose can be more easily cleaned to higher levels for cryogenic and sensitive applications.

29—Outdoor oil circuit breakers have improved relay panel

Types OZ and FZO Outdoor Oil Circuit Breakers of Allis-Chalmers Mfg. Co. are now equipped with a redesigned relay panel affording greater accessibility for

installation and maintenance. Wiring ducts, located at the rear of the panel, offer time and labor saving features for holding, protecting and distributing wires. It eliminates lacing in the field, company points out; it is durable, non-combustible and non-warping, and can be cut with a hacksaw. With the new wiring duct, you need only to lay the wires in place and snap on the cover.

30—Inverting device forces tank fumes high into the air

Fumes and gases vented from a storage tank, as product is pumped in, are directed high into the air by the Vapor Inverter. It is to protect personnel on nearby tank roofs and ground areas. The device is introduced by The Johnston & Jennings Co. Although it mounts on the tank's pressure relief vent, the Vapor Inverter does not impair its flow capacity, manufacturer states. It diffuses snow, and the bottom holes facilitate rapid drainage of water. According to company, 80 per cent or more of the gases and fumes vented from the tank are directed up into the air by it, at velocities from 13 to 25 mph. It comes in seven sizes from 2 to 12 in. to fit any make of relief vent. Data Sheet 100-37-0 gives information.

CONSTRUCTION NEWS

Ozark, Ark. — Arkansas State Electric Coöperative Corp, 3111 East Broadway, North Little Rock, Ark., is considering plans to construct a steam-electric generating plant on a large site located here. New installation, to be known as the Thomas B. Fitzhough Power Plant, will cost an estimated $10,000,000 when completed. Preliminary engineering work is already under way, and construction work is planned as soon as this is completed. Burns & McDonnell, Kansas City, Mo., is the project's consulting engineer.

Eureka, Calif. — Pacific Gas & Electric Co, 245 Market St, San Francisco, Calif., has announced that it has received permission from the Atomic Energy Commission, Washington, D.C., to construct a 50,000- to 60,000-kw nuclear power plant on Humboldt Bay, near here. Plant, which is currently expected to cost about $19,500,000, will be built by the General Electric Company for Pacific Gas & Electric Co. Proposed plant is somewhat isolated from the rest of company's system, where fuel oil costs are higher than elsewhere.

Los Angeles, Calif. — City of Los Angeles, City Hall, and City of Pasadena, City Hall, have announced joint plans, under consideration, for the construction of a 50,000-kw nuclear power plant with a boiling-water reactor, at Haskell Canyon, Los Angeles County. Negotiations between the two cities are already under way with the Atomic Energy Commission, which will need Congressional approval before work can begin. Allis-Chalmers Manufacturing Co, Washington, D.C., has offered to design and construct the project at a reported cost of $10,760,370. Project is a prototype for a 300,000-kw reactor. Completion of the project is planned for the summer of 1964.

Redding, Calif. — Bureau of Reclamation, Department of the Interior, Denver Federal Center, Denver, Colorado, has announced a contract award in the amount of $1,379,732 in connection with the Bureau's Central Valley project to furnish and install two 74,444-l va generators to the Hitachi New York Ltd, 501 Fifth Ave, New York, N.Y., for the Clear Creek Power Plant, located here. Work on foundation preparation will begin at an early date, and installation is scheduled for completion early in 1962.

Vallecitos, Calif. — Combined under the name of Empire State Atomic Development Associates, Inc, seven New York utilities have announced a fund of $10,000,000 to be spent in a quest for competitively priced nuclear electric power. The research race will pit boiling-water reactors against gas-cooled, graphite-uranium reactors in the production of 1000-deg steam at pressures between 1500 and 2000 psi, which is needed to run small-diameter turbines to keep capital costs low enough to make atomic power competitive with fossil fuel power. Biggest construction expenditure for now will be an $8,000,000 boiling-water reactor to be built at General Electric's research center located here. This 5000-kw reactor will be used to superheat steam produced by an existing power plant.

Crawfordsville, Ind. — Board of Public Works and Safety, City Hall, this city, has plans under way to install an auxiliary generating unit in the municipal power plant. Work will begin soon on the installation of a 12,650-watt generator estimated to cost about $3,500,000. Plant is scheduled for completion early in 1962.

Gaithersburg, Md. — General Services Administration, Public Buildings Service, 19th and F sts, N.W., Washington, D.C., has authorized plans for construction of 20 buildings for the Bureau of Standards. First phase of the project calls for laboratory site preparation, roads, utilities, power plant, and auxiliary equipment which will cost approximately $23,500,000 out of a planned total expenditure of $100,000,000. A preliminary budget of $10,000,000 has already been appropriated for the work which has begun.

Boston, Mass. — New England Electric System, 441 Stuart St, has authorized capital expenditures for 1961 of $42,000,000. Major item in this budget is construction of the new Brayton Point steam plant now under way at Somerset, Mass. New facility will consist of two 250,000-kw units which will cost an estimated $80,000,000 and will, when completed, be the largest generating plant in New England. First unit is scheduled to go on line in 1963; the second in the summer of 1964. Construction outlays will be spread over a four or five-year period.

Pittsfield, Mass. — General Electric Company recently announced that it had moved 710,000 volts through an experimental extra-high-voltage system, near here, opening up prospects of cheaper electric power and giving the United States the world lead in high-voltage experiments. The prototype system cost approximately $7,500,000 and has a maximum theoretical capacity of 750,000 volts. Electric power enters the system at 115,000 volts from a nearby Western Massachusetts Electric Co line. It is then fed through the world's highest voltage power transformer, where voltage is stepped up to between 460,000 and 750,000 v. Line is financed by a group of 13 manufacturing and engineering firms, with General Electric's power transformer department in Pittsfield, Mass., acting as coördinator of the project.

Columbia, Mo. — As previously reported in these columns in Nov 1960, City Council, City Hall, of Columbia, Mo., had plans for expansion and improvement in its municipal power plant to include installation of a 22,000-kw generator and auxiliary equipment, 220,000-lb boiler with equipment, coal bunkers, electric power interchange, and installation of additional distribution facilities. Work was to begin under supervision of Lutz & May Co, Kansas City, Mo., contingent on a bond issue which was defeated in the last election. Work on the project will be temporarily abandoned at this time.

Columbia, Mo. — Board of Trustees, University of Missouri, 116 Jesse Hall, is considering plans to install a nuclear research reactor on the campus of the University located here. Plans call for installation of a small nuclear research reactor, laboratory, and an office and cooling tower buildings. Work will begin at once under plans of C. L. T. Gabler & Associates, Detroit, Mich. Cost of the entire project is reported to be approximately $1,875,000. Work is being scheduled for completion by the spring semester of 1962

Hallam, Nebr. — The Atomic Energy Commission, 1901 Constitution Ave, N.W., Washington, D.C., has announced what is claimed to be the most complete radioactive monitoring system in any one installation at its nuclear power plant located here. System which measures radioactivity in gases, waste material and other areas was built by the Victoreen Instrument Co, Cleveland, O., under contract to Atomics International, a division of North American Aviation Inc. Company also designed the reactor for the facility. The control center, principal unit of the system, records measurements from the various remote monitoring units. The control panel gives an immediate reading of the amount of radioactivity at any particular place.

Kimball, Nebr. — A $59,588 Kimball, Nebr., substation contract to provide electricity for Rural Electrification Administration lines in the vicinity of this place was awarded to the C.S.P. Engineering Co, Casper, Wyo., low bidder on the project. Station is being built for the Bureau of Reclamation as part of the Missouri River Basin Project and will be located seven miles southeast of here. The substation will be approximately 260 ft × 160 ft, and construction includes excavation of 2000 yd of earth and 1400 yd of embankment. Substation site is located on Lodgepole Creek, a tributary of the South Platte River.

Goldsboro, N. C. — Carolina Power & Light Co, 419 Fayetteville St, Raleigh, N.C., has announced that it now has under construction the world's first completely automated, coal-fired, steam-electric power plant on a large parcel of land recently acquired at this location. New plant was engineered by Ebasco Services, Inc, 2 Rector St, New York, N.Y., which is supervising construction work. Plans include installation of a steam-electric generating unit with an initial capacity of 320,000-kw, high-pressure boilers, and auxiliary equipment. Plant, to cost in excess of $8,000,000 and to be in service by the summer of 1962, will be automated by the Control Systems Division of Daystrom, Inc.

Portland, Ore. — Portland General Electric Company, 621 S.W. Alder St, this city, has authorized a major expansion program of its transmission and distribution lines, including substation construction and improvements. Work on company service lines is already under way and when completed will represent an investment of approximately $17,000,000. Completion of the expansion program is targeted for the close of 1962.

Parr, S. C. — Four Carolina-Virginia utilities have jointly announced the start of construction on a nuclear power plant to be erected on a large site near here. Reactor of the pressurized-water type will have an initial capacity of 17,000 kw and will be the first in the Southeast. Work is well under way, and completion is sched-

uled for late 1962. Project will cost the utility group about $28,000,000 and the Atomic Energy Commission about $15,000,000 when completed. The new Carolinas-Virginia Nuclear Power Association plant will be located on a 900-acre site adjacent to South Carolina Electric & Gas Co's hydroelectric and steam-generating plants already located here. Plant will be used as a test model for larger plants, planned for the future.

Columbia, S. C. — South Carolina Electric & Gas Co, 328 Main St, this city, has announced purchase of four gas turbine package power plants from the General Electric Co, Schenectady, N.Y. General Electric has developed the units, which can be purchased for about $100 per kilowatt and can be in operation 10 days after delivery. Units which are described as ideally suited for peak load, emergency and standby service will be installed at Beaufort and Charleston, S.C. First two units are scheduled to go on the line in June and the other two in mid-1963. Total expenditure including installation is reported to be about $4,500,000.

Knoxville, Tenn. — Tennessee Valley Authority, New Sprankles Bldg, has authorized contract awards of $7,400,000 for supplies and construction items for dams and locks for hydroelectric projects now under construction. Largest contracts went to McGraw-Edison Co's Pennsylvania Transformer Division, Canonsburg, Pa., for transformers and neutral reactors, and to General Electric Co for similar items. Both contracts were over $1,000,000.

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Computer Control At Little Gypsy

Is It Justified Economically?

By W. T. Hess, vice-president and chief engineer, Louisiana Power & Light Co, at a recent meeting of the Instrument Society of America

WE WERE ATTRACTED to the use of a computer for control at Little Gypsy Station because of the possibility of increasing the safety to personnel and equipment, and believe there are other possibilities for economy sufficient to justify the installation to obtain the actual experience.

We will operate Little Gypsy with the same organization that would be used for any other single unit station that we might install today. We are doing this, first, because we feel certain that there will be a normal amount of "bugs" to be shaken out before we are ready to turn the job of operation over to the computer; and second, we wish to be able to obtain comparisons of computer operation with manual operation and with normal automatic controls.

The organization chart provides for an operating force of three men per shift. These men will work 40 hours per week each on a shift schedule. The electrical and mechanical maintenance personnel normally works eight hours per day for five days per week. It should be noted that the operators have the word "maintenance" attached to their titles. What is usually called an "auxiliary operator" is called a "maintenance operator." This is perhaps a clumsy title, but we could not come up with a better one. The thinking behind this is that the auxiliary operators have practically no auxiliaries to operate. Even without the computer, the control for starting and stopping all auxiliaries is on the centralized control board.

Their duties, therefore, include such things as keeping oil in the bearings and the various minor tinkering that needs to be done with equipment during the shift operations. Major maintenance will, of course, be handled by the maintenance forces. For the present, the station superintendent reports to the vice-president and chief engineer. There is, therefore, no difference between the organization and management for Little Gypsy and for our other two generating stations. Any such changes will be the result of experience gained in the operation.

Following a few near misses in our own stations and some rather serious accidents to some other large units in

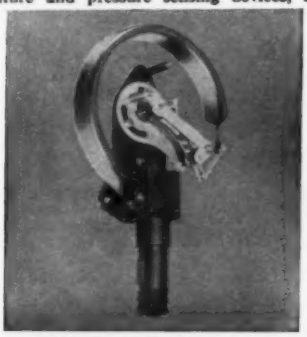
THE LONERGAN LINE

HOW TO MAKE A GOOD IDEA BETTER

by Norman J. Smith

In this hurry-up age of missiles and electronics, it is often possible to overlook the fact that because a device or an idea is new, it is not necessarily the best.

For example, while there are many temperature and pressure sensing devices, none



has such universal application as the Bourdon tube, which was first conceived in 1849 by a French engineer, Eugene Bourdon.

Today, a modern "C" type Bourdon tube gauge, such as the Lonergan Maximon makes full use of Bourdon's original idea. At the same time, it utilizes the finest materials such as K Monel stainless steel, beryllium, copper and many, many others in order to improve Bourdon's basic invention. Other improvements are: twisted spiral tubes to measure the output of pressure transducers; long helical tubes with heavy walls to measure pressures up to 100,000 psi; and small tightly coiled tubes for movementless gauges.

While the power plant man with a gauge problem isn't concerned with all of these forms, it is interesting to note that in his application for a patent more than a hundred years ago, Bourdon anticipated all of these present day variations. He claimed application on all forms of curved or twisted tubes whose transverse sections differed from circular forms for temperature and pressure measuring, indicating and controlling of fluids.

The Lonergan gauge today incorporates all of the known advances in the Bourdon tube in any one of three lines. For applications requiring the finest gauge available anywhere, the Lonergan Maximon is the choice.

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Norman J. Smith

Chief Engineer, Instrument Division

Lonergan

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the country, we began to think of the computer as a possible safety device for the control of generating units. Since most serious accidents occur during start-up or shutdown, the computer should control not only normal operation on-line but the start-up and shutdown procedure.

About the time that construction was started for our Sterlington No. 6 unit for operation in 1958, Daystrom offered a solid state digital computer with a guarantee of 99 per cent availability on a six months' test period. It was decided to install this computer at Sterlington to monitor essential temperatures and pressures, to record the data thought necessary for historical purposes, and to make the computations of over-all thermal efficiency for the new unit and for the No. 5 unit installed in 1943.

Even before completion of the test run on the computer, the early experience indicated that it would have a very high degree of reliability. Therefore, during the early stages of design for Unit No. 1 for the Little Gypsy Station, it was decided that this computer would be adequate for the control of automatic operation for the plant.

Justification

Estimated cost for providing for computer control of a unit similar to the Sterlington Unit No. 6 was $600,000. The problem was: could this expenditure be justified? Frankly, the economic justification as of today is uncertain, but it is felt that a potential exists for the improvement of safety to manpower and equipment, the improvement of fuel economy, the reduction of manpower required for operation, and the reduction of maintenance because of closer adherence to temperature and pressure limitations.

Improvement in safety to the equipment offers the greatest potential saving, yet is the most difficult to substantiate except on the basis of probabilities. Statistics studied indicate a probability of about one-third for a major, serious accident during the service life of a generating unit. With units of the size being considered, the cost of such serious accidents has run as high as $4 million, not including the cost of replacement energy during the outage time. Thus, the elimination of this possibility alone can justify the computer control. Of course, we always feel that it can't happen to us, but the statistics say it can.

The improvement in fuel economy is something that will be ascertainable by trial runs with computer control and without it. There is no way of determining what, if any, gain can

save on installation and maintenance

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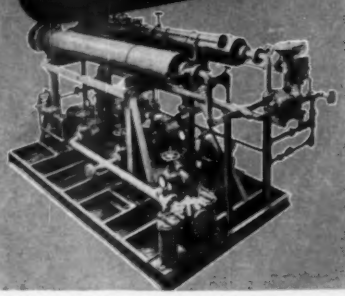
FUEL OIL PUMP and HEATER SETS



Use an Eagan "pre-packaged" fuel oil pump and heater set for the preparation of heavy oil for combustion. You save time and money because units are completely assembled, ready for immediate installation. Only connections to oil and steam supply, burner, by-pass and relief lines have to be made and you avoid the combustion difficulties so often caused by field assembled combinations.

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- **Compact units save space.**

EAGAN fuel oil pump and heater sets heat to 300° F, pump to 400 psi and have capacities to 3000 gph. Single or duplex units are available for steam or electric drive. Duplex "electro-steam" sets provide for electrical failure by incorporating one steam pump and one electric motor driven pump. Other EAGAN sets can be made to your special requirements.

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be obtained until it has been tried. However, a saving of one-half of one per cent in fuel consumption for a unit of this size will justify the expenditure of from $125,000 to $175,000. It does not stretch the imagination too far to assume that a fuel saving of that magnitude is possible.

We believe that future units can be installed without the same increase in manpower that would be experienced without computer control. There is very considerable potential saving here because the elimination of one shift position will justify the investment of about $250,000.

There should be some saving in routine maintenance because of closer control over temperature and pressure tolerances. Capitalized value of such savings might amount to $50,000 to $100,000.

At Little Gypsy, we have not taken full advantage of the computer possibilities for control in that we have superimposed the computer upon the automatic controls that would be used normally in one of our stations, such as combustion control, feedwater control, etc. It is possible, I believe, to dispense with other controls (where economical) and turn the entire job over to the computer. Little Gypsy No. 1 can be operated exactly as our other units, without the computer. The computer can, however, when it is in operation, reach through these controls to optimize the operation or to take over for safe control just as an operator could do in the event of malfunction of any controls.

Estimated cost for computer control above the cost of a monitoring and results computer is $630,000. The capitalized value of potential gains are estimated to be:

	Probable Maximum
Reduction of major mishaps	$1,500,000
Increased fuel economy	175,000
Reduction of manpower	500,000
Reduction of maintenance	100,000
	$2,275,000

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Recently out of print, the Power Engineers' Valve Manual is again available. It covers the basic types of valves. Although there are hundreds of different styles, all are modifications of the types covered in the Manual.

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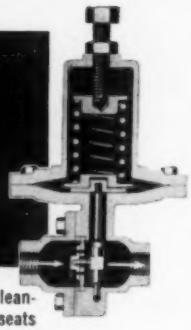

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1,000,000- kw Turbogenerators Predicted

TURBINE GENERATORS rated at 1,000,000 kilowatts will be producing power in the United States within the next 15 years. This prediction was made by Electric Utility Engineer Clarence J. Baldwin, of Westinghouse Electric Corporation, in a report prepared for the AIEE.

The significance of this prediction is startling in view of the fact that the largest unit operating in the U.S. today is rated at 475,000 kilowatts.

Mr. Baldwin reported that Westinghouse undertook a two-year study whose results determined that such higher rated units can be operated economically. The method employed was termed "powercasting," which involves the use of computers to simulate detailed operations of a utility in the future.

In effect, by programming the future into a computer, utility specialists are able to build a model electric system, in the computer, that will actually operate like a full-scale system.

For example, Mr. Baldwin points out, "In 10 minutes, a high-speed digital computer can reproduce 20 years of experience on a mathematical model. Day by day, the model determines which units must be run to supply the load. It starts up these units, adds generating capacity and interconnections with other utility systems and builds transmission systems as required."

At the end of "20 years" of experience, the computer records all decisions made along with dates when additions should be made. It calculates present worth of all revenue requirements, total capital needs, and production and operating costs.

In the study a comparison was made of a number of feasible expansion patterns for the system. It was indicated that the 1,000,000-kw pattern proved economically superior to one restricted to 500,000-kw units over the next 20 years. Baldwin reported that its economic superiority was unchanged by variations in installed plant cost.

It was shown in the study that patterns using units larger than 1,500,000 kw could be economical were it not for increasing internal transmission costs. The concentration of capacity in one location on some utilities increases transmission costs enough to overcome economies that would otherwise be attained.

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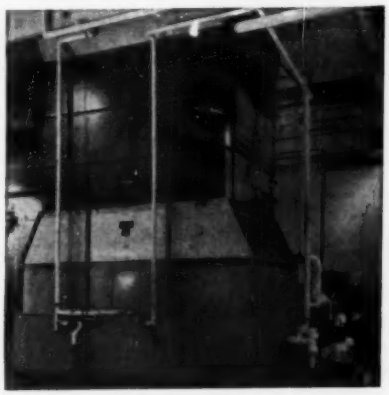

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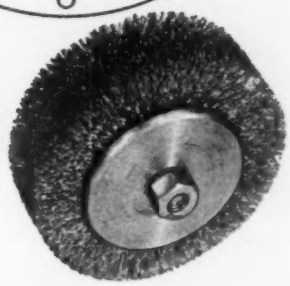
The American Magazine Group

ROTOJET®
Tube Cleaners

Clean tubes and pipes from ½" to 12" I.D. THOROUGHLY QUICKLY

ROTOJET Model 512 Air-driven Motor, universal joint, swing-frame head, and solid brush.



ROTOJET Junior Model S32 Air-driven Motor, universal joint, cone cutter.

ROTOJET Junior Model C434 Air-driven Motor, flexible coupling, expanding brush.

ROTOJET Model C-525 Air-driven Motor with swing-frame head and universal joint.

ROTOJET Model C-526 Air-driven Motor with pivot head and universal joint.

Our large stock of Rotojet air-driven and water-driven tube cleaners, accessories, and repair parts for straight and curved tubes, pipes, and transfer lines is available to meet most requirements without delay. Tube cleaner specialization for 43 years assures satisfactory results from any Rotojet equipment we recommend. Send for Bulletins J-410 and R-105. For quick action wire or phone, HUmboldt 3-0570.

ELLIOTT COMPANY – ROTO PLANT
Tube Cleaner Specialists Since 1910

147 Sussex Avenue, Newark, N. J.

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FIRST

AMCA APPROVED

BELT-DRIVEN VANEAXIAL IN THE FAN INDUSTRY

First in the industry to be approved by AMCA and first in their class to be tested and rated as they are most commonly used, Aerovent Belt-Driven Vaneaxial Fans permit you to select exactly the unit you need without the necessity for recalculating performances to accommodate belt and drive losses. And, they are rated without accessory transformations, which means that performances are even more attractive when entrance orifices or tapered cones are required.

Furnished in sizes 12" to 60" for capacities to 74,860 CFM, each unit also carries Aerovent's own Certified Performance label—your guarantee that our equipment will perform as represented.

Write for Bulletin 450

Air deliveries of all Aerovent equipment are tested and rated in accordance with established and accepted codes and each unit is guaranteed by the manufacturer to deliver its rated performance.

CERTIFIED PERFORMANCE

Aerovent Fans

Aerovent

FAN COMPANY, INC.

ASH and BRUSH STS. PIQUA, OHIO

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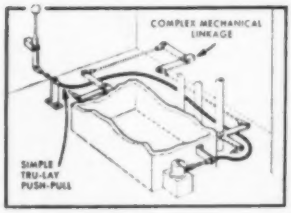
TRU-LAY PUSH-PULL DATA FILE SHOWS HOW TO SIMPLIFY AND IMPROVE DESIGN



Push-Pull remote controls, shown here, are flexible, have but one moving part, and give a lifetime of accuracy. Mechanical linkages are complex, are made of many parts, wear at many points, and produce increased backlash, lost accuracy, and vibration rattles.

This Push-Pull Data File—containing 7 engineering bulletins—will show you how these flexible controls have eliminated mechanical linkages on hundreds of products. You can make *your* products more useful, easier to sell, with Push-Pull controls. Write for your Data File today.

Automotive and Aircraft Division

AMERICAN CHAIN & CABLE

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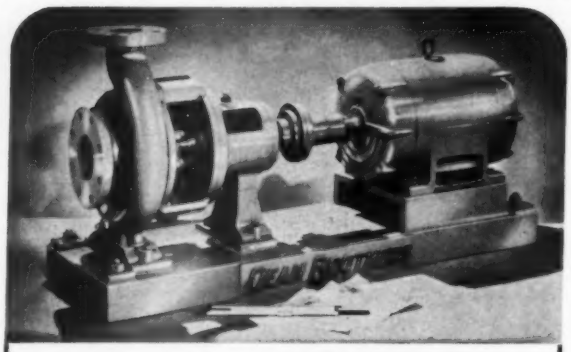

FOR EASE IN SOLVING CORROSION PROBLEMS CHECK THE 4 E's OF DEAN BROTHERS TYPE pH PUMPS

✓ **Easy to Select**—28 sizes (14 horizontal, 14 vertical) available in 14 corrosion-resistant alloys, to fit your special pumping problem.

✓ **Easy to Install**—Centerline suction and discharge connections. No need to remove from suction or discharge piping for servicing.

✓ **Economical to Buy**—Low first cost combined with easy servicing and maximum interchangeability of parts make pH pumps lowest cost in the long run.

✓ **Economical to Operate**—Fully open impellers for slurries and clear liquids contribute to long, trouble-free service life with minimum down-time.

For Complete Information Write for Circular 217

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS 7, INDIANA

The Best Is Our Standard

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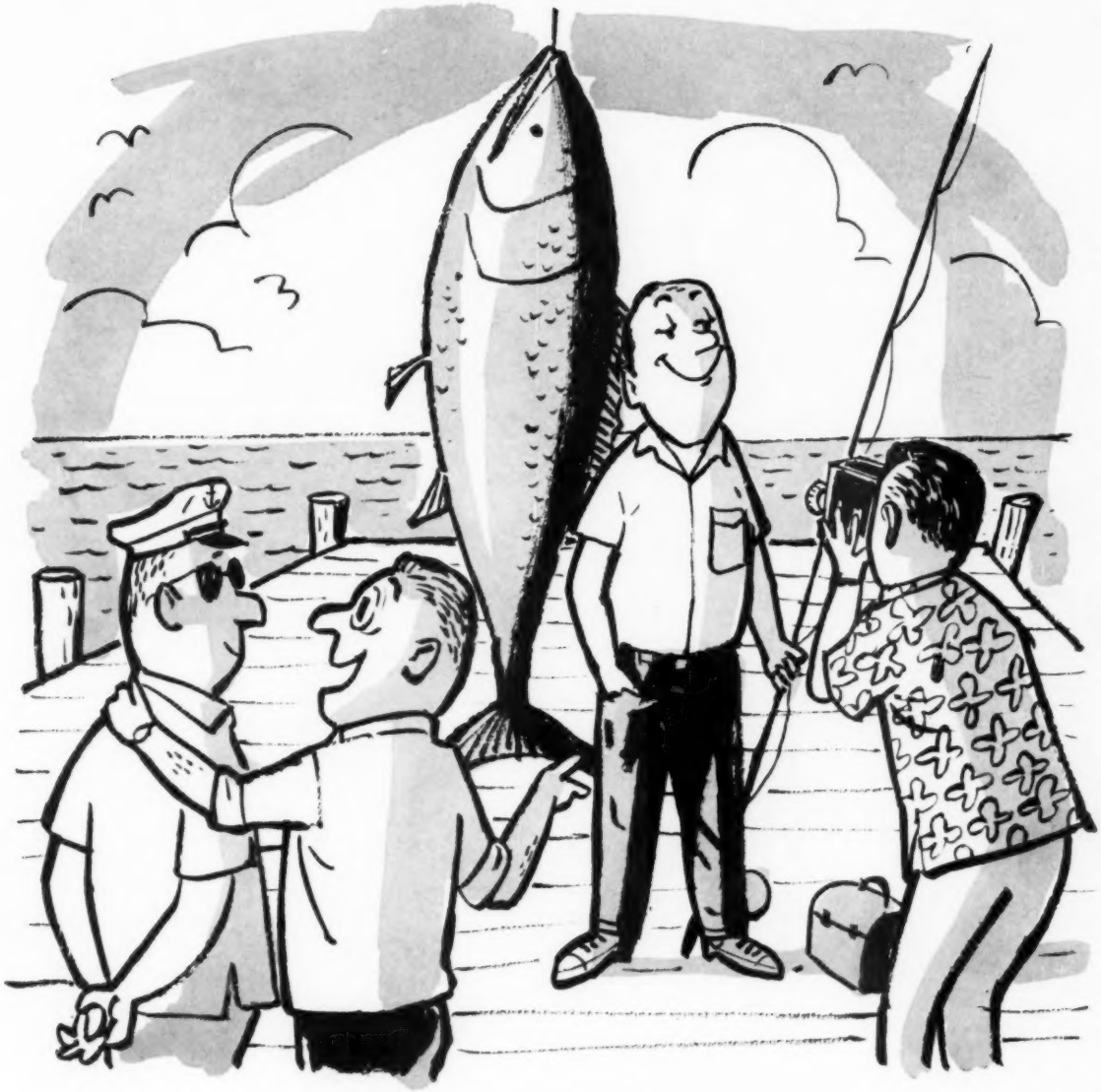


"It's the same expression he had at the plant the day he discovered how to lower the cost per 1000 pounds of steam."

That proud feeling begins when you realize this: the coal that will produce the most efficient, most economical results in *your* burning equipment is coal *prepared* for your burning equipment. That's why ISLAND CREEK PRECISIONEERED COAL can so often reduce net steam costs. It's coal from superior southern seams, prepared scientifically to your exact specifications with precision engineering techniques and strictest laboratory controls. Write or phone to set up a discussion that may well lower *your* steam costs. No obligation, of course.

ISLAND CREEK Precisioneered Coal

You can depend on Island Creek . . . a career company dedicated to coal

ISLAND CREEK COAL SALES COMPANY, Chafin Building, Huntington 18, West Virginia • Chicago • Cincinnati • Cleveland • Detroit • Greensboro • New York • Pittsburgh

For more data circle 555 on Post Card

Quality *costs less* in the long run!

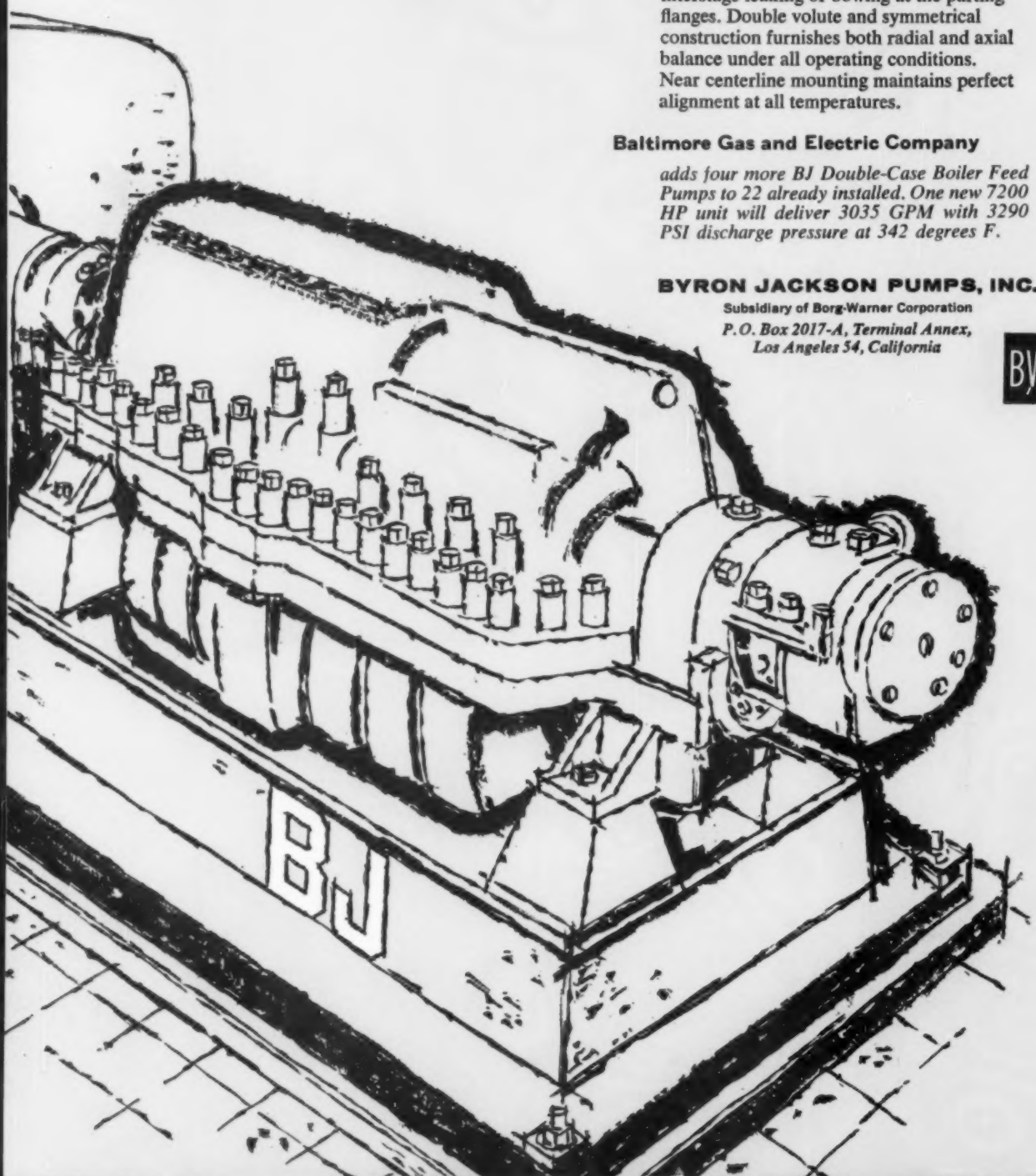
BJ High Pressure Pumps

For high pressure, high temperature and high speed pumping, an extra safety factor is built into this DVMX Pump—*the safety of a quality product!*

Clean and compact, BJ's advanced design allows double-row bolting to prevent interstage leaking or bowing at the parting flanges. Double volute and symmetrical construction furnishes both radial and axial balance under all operating conditions. Near centerline mounting maintains perfect alignment at all temperatures.

Baltimore Gas and Electric Company

adds four more BJ Double-Case Boiler Feed Pumps to 22 already installed. One new 7200 HP unit will deliver 3035 GPM with 3290 PSI discharge pressure at 342 degrees F.



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Subsidiary of Borg-Warner Corporation

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